

Nease Chemical Superfund Site Salem, Ohio FS Alternatives Screening October 15, 2003

- 2003 Groundwater Monitoring
- Operable Units
- Risk Driving Chemicals
- Remedial Action Objectives
- Technology Review
- Alternative Screening

US EPA RECORDS CENTER REGION 5

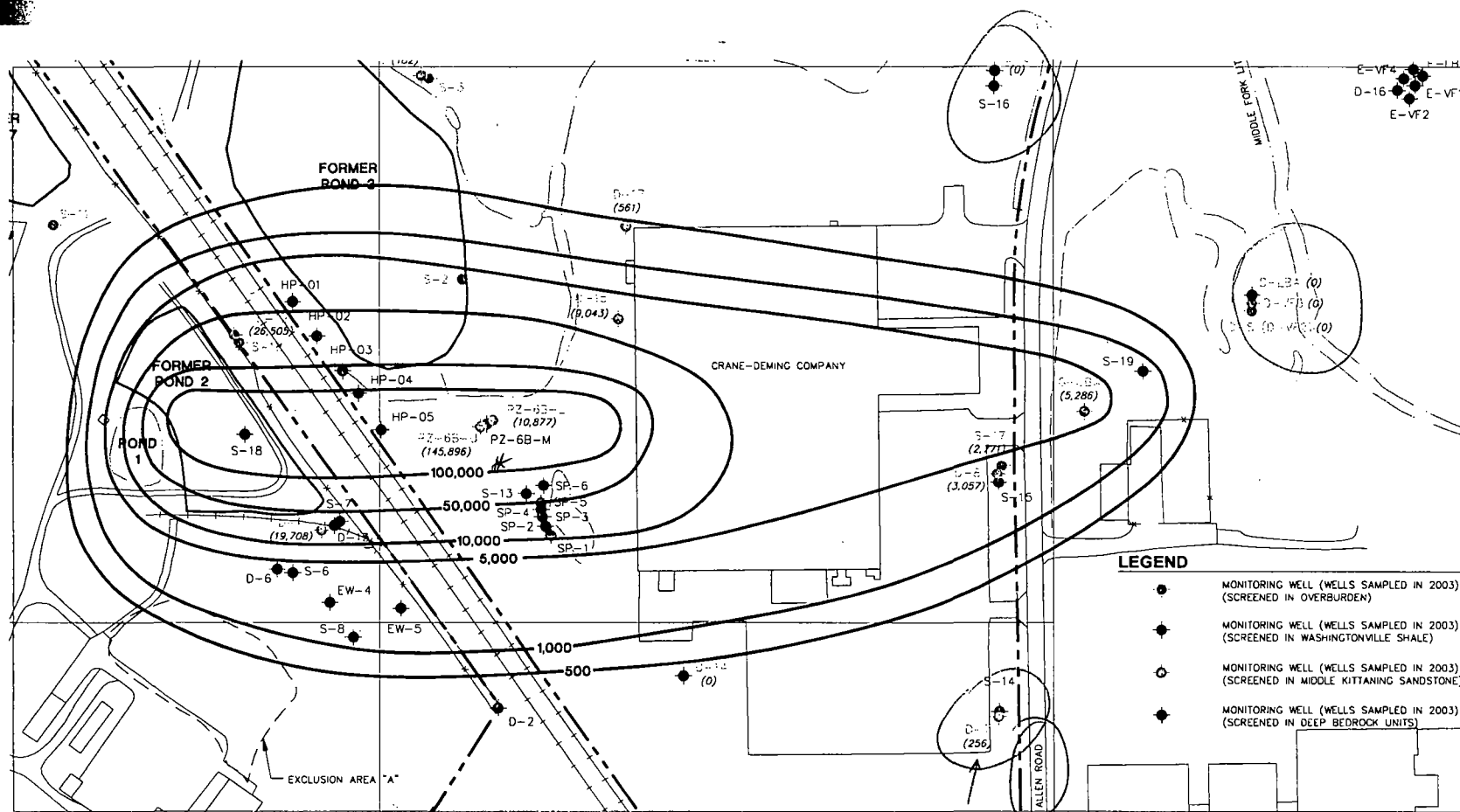


397552

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10/15/03



Bedrock – Total VOCs (2003)

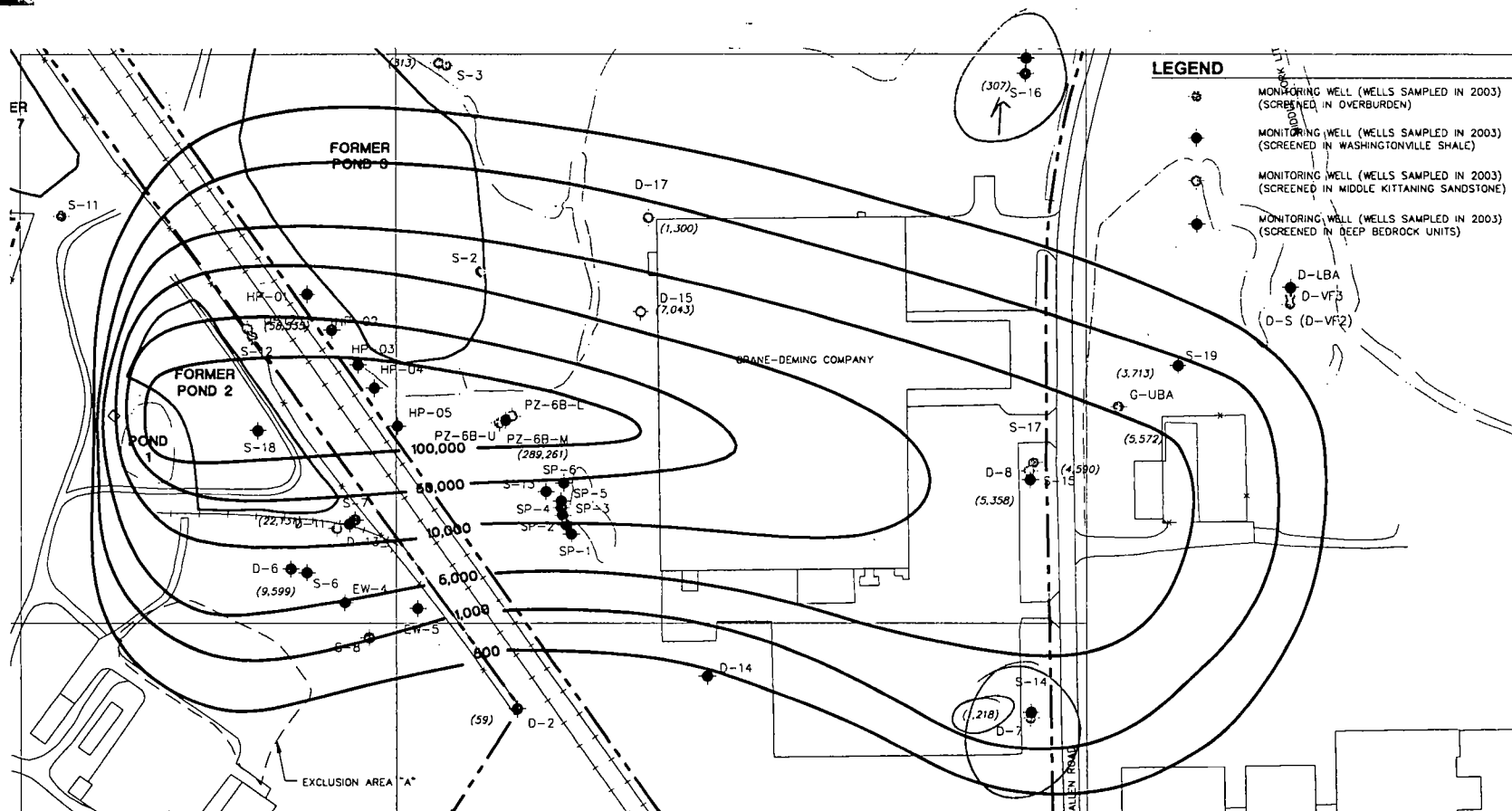


W24
1,218 ppb

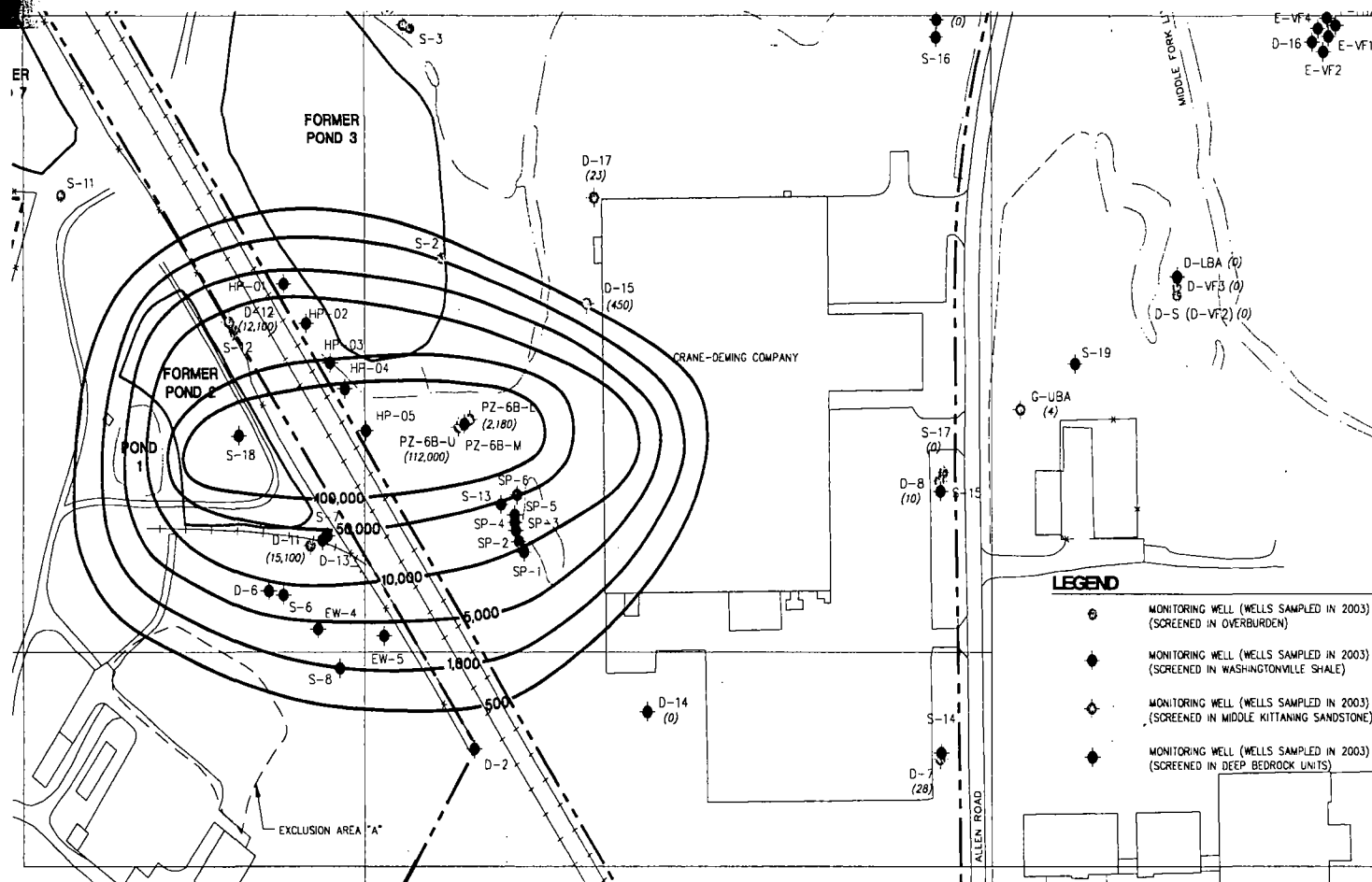


* ppb

Bedrock – Total VOCs (1997)

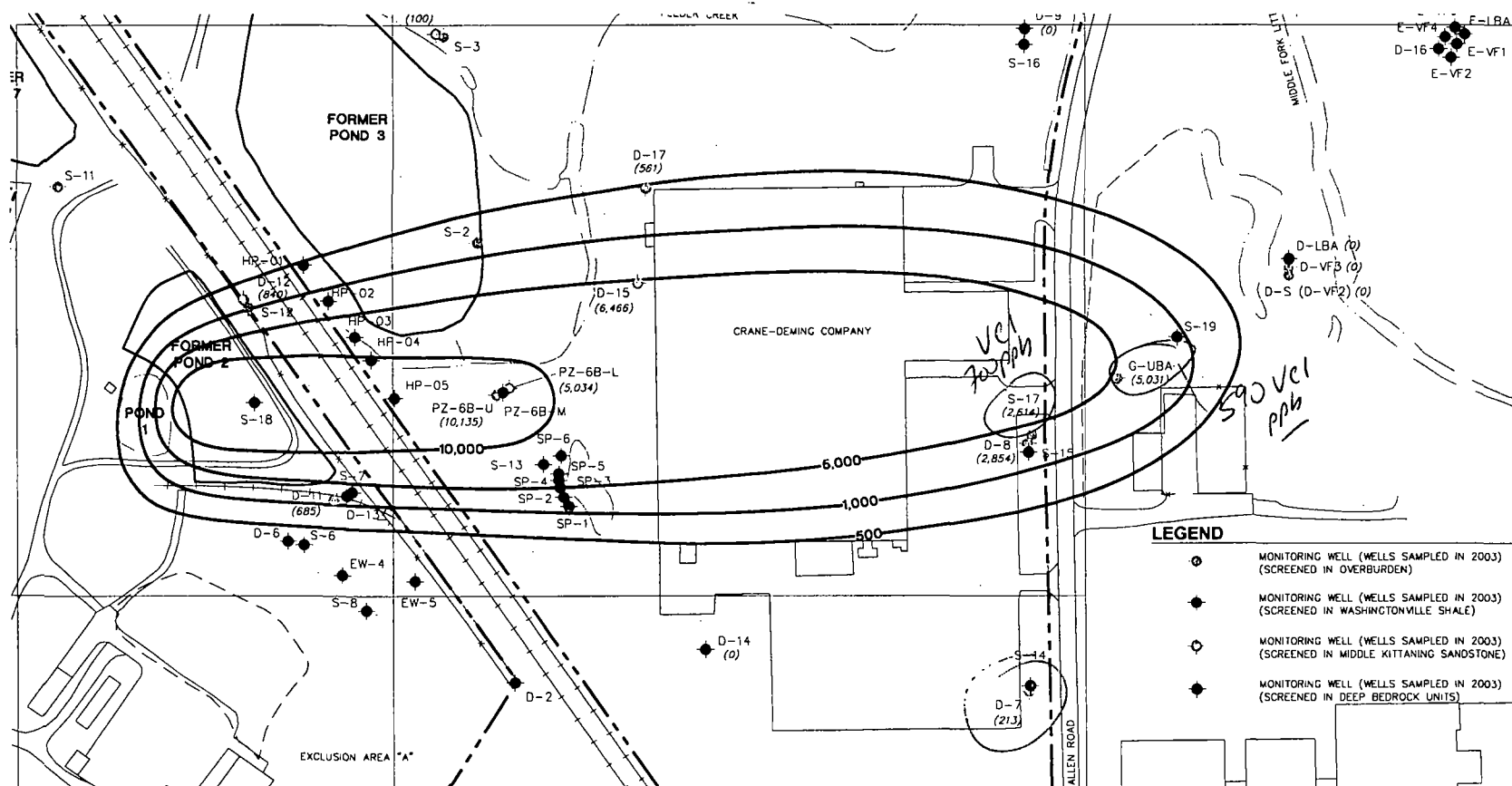


PCE+TCE in Bedrock (2003)

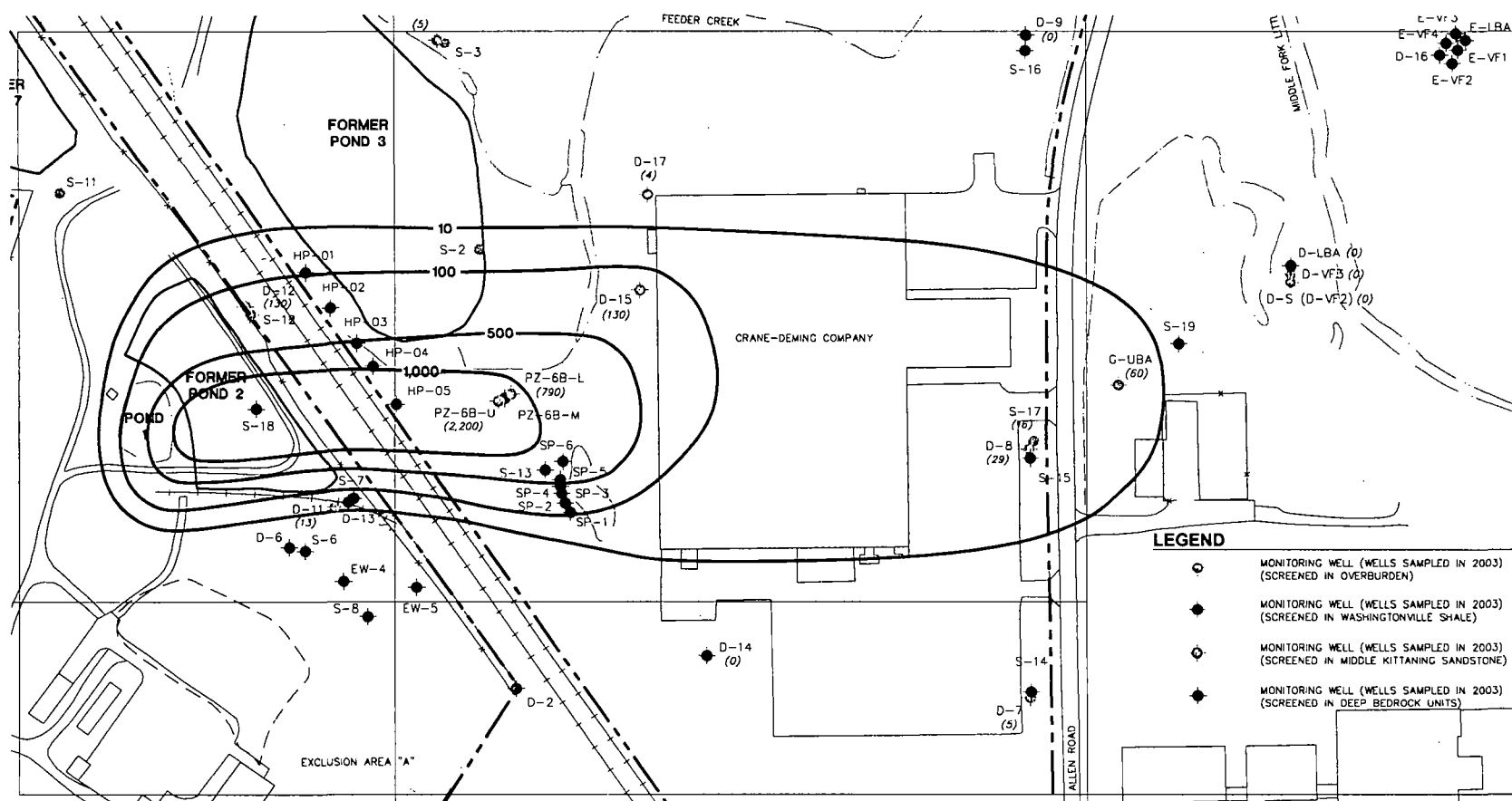


daughten products

cisDCE+vinyl chloride+ethene in Bedrock (2003)

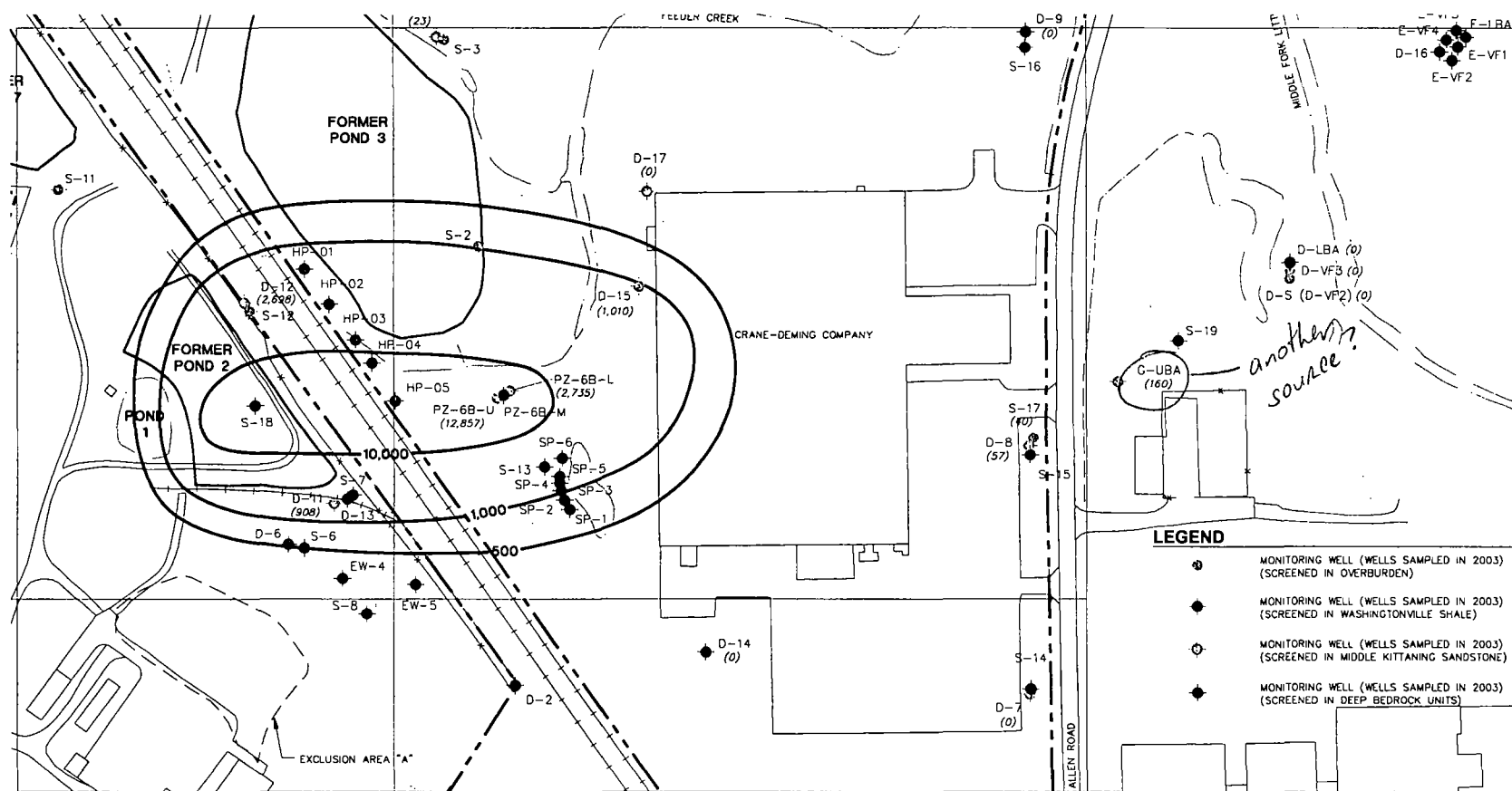


1,2-Dichloroethane in Bedrock (2003)

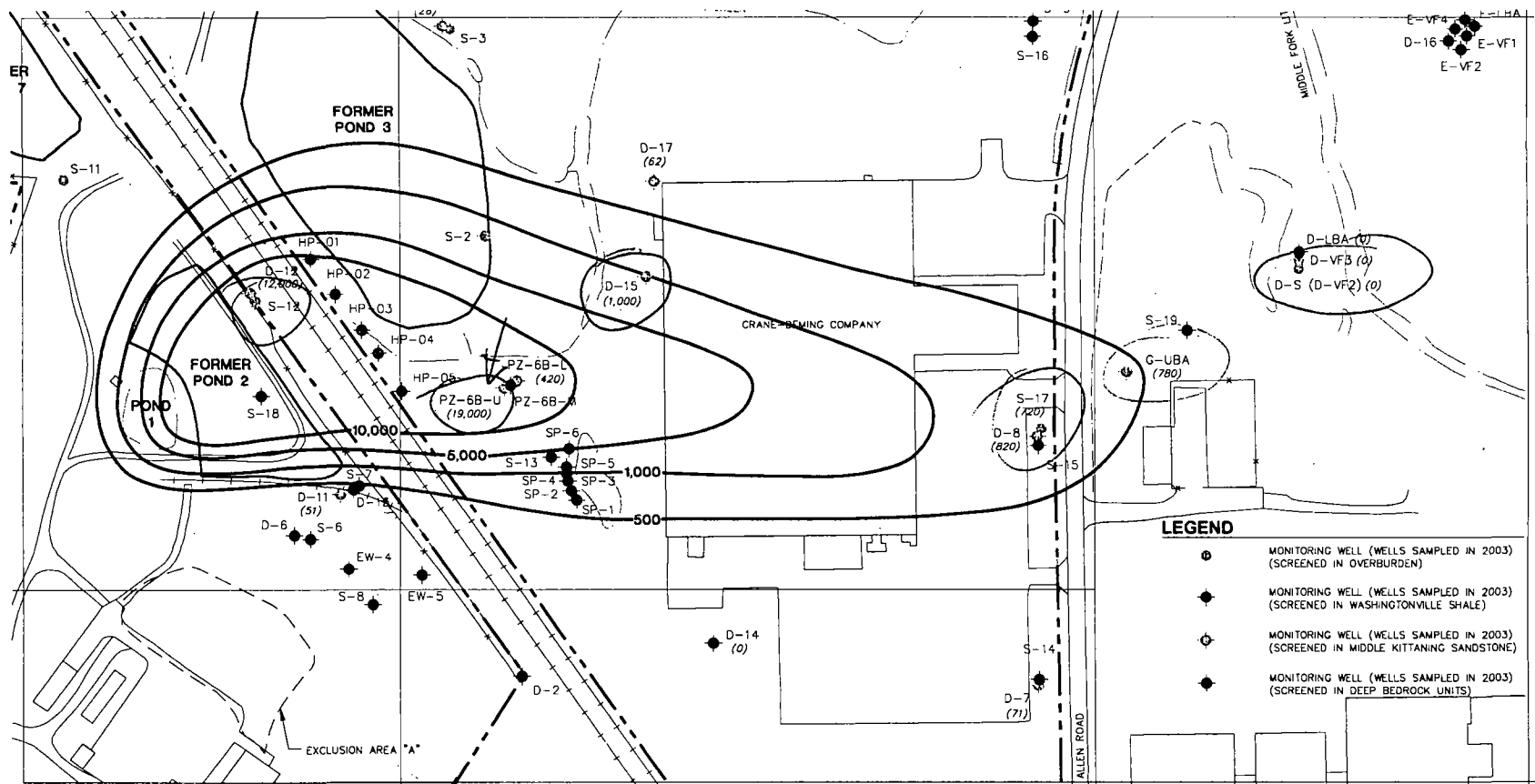


Large majority of [BTEX] is in bedrock

Total BTEX in Bedrock (2003)

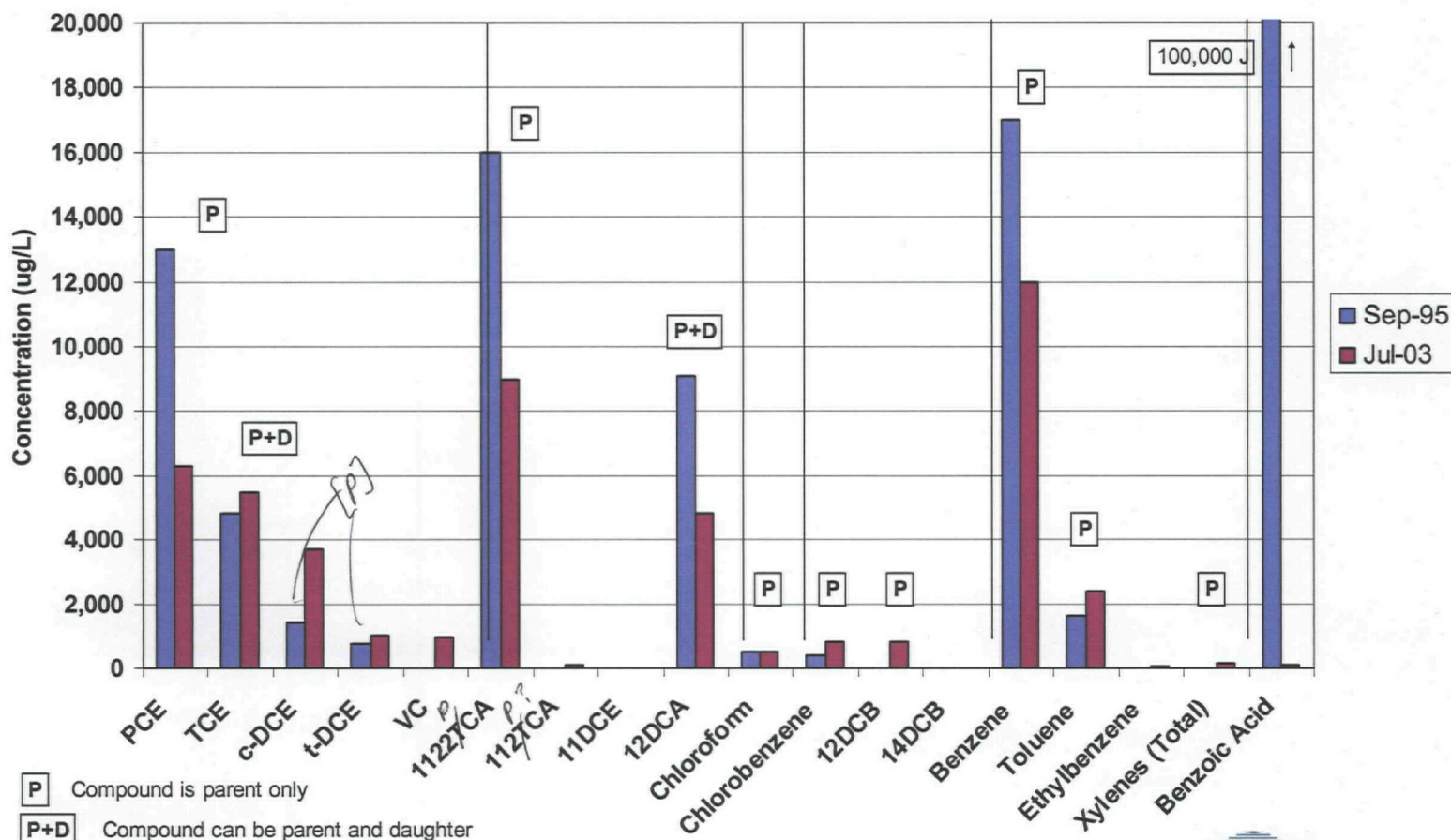


1,2-Dichlorobenzene in Bedrock (2003)

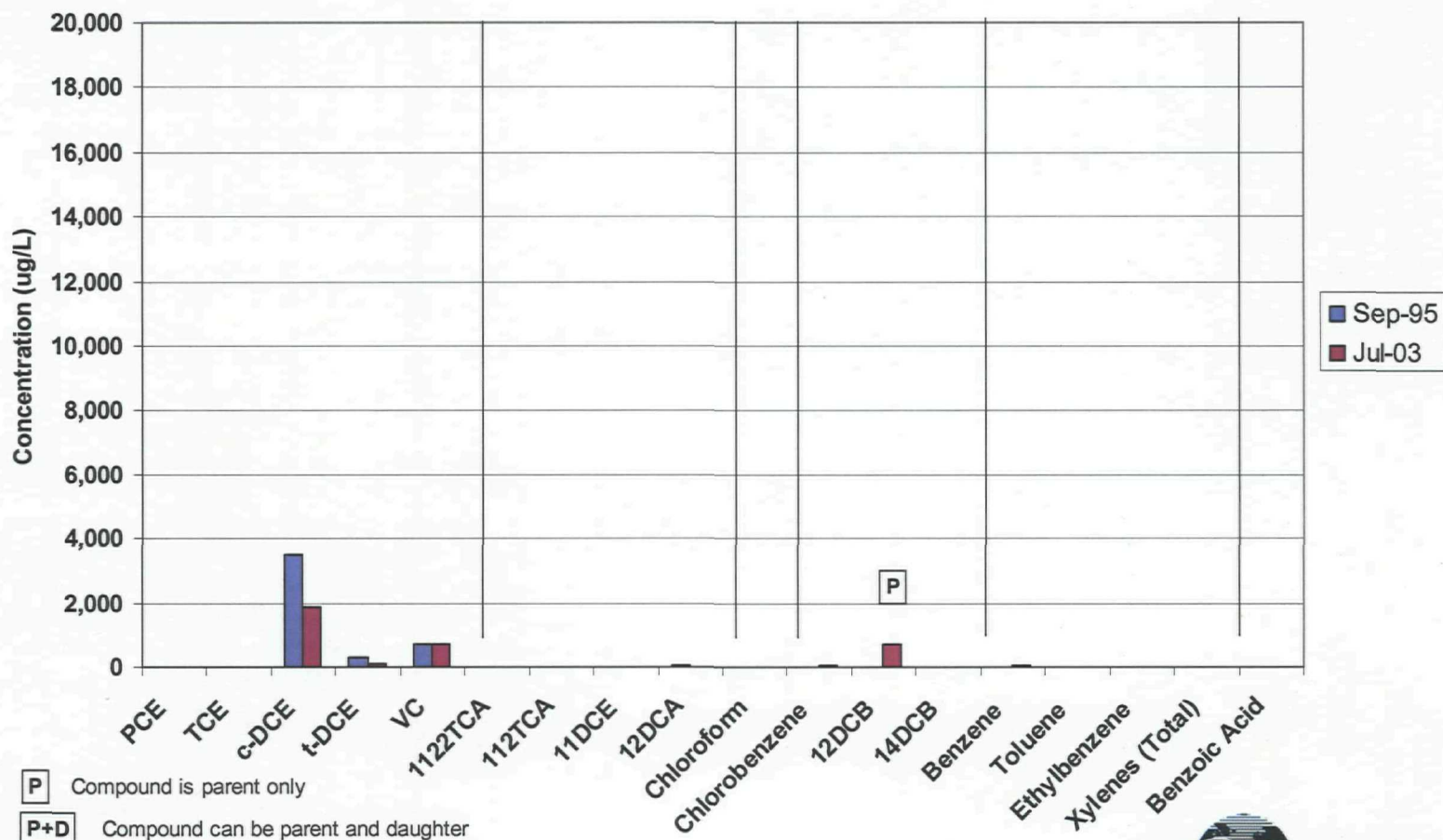


By former Paul 2

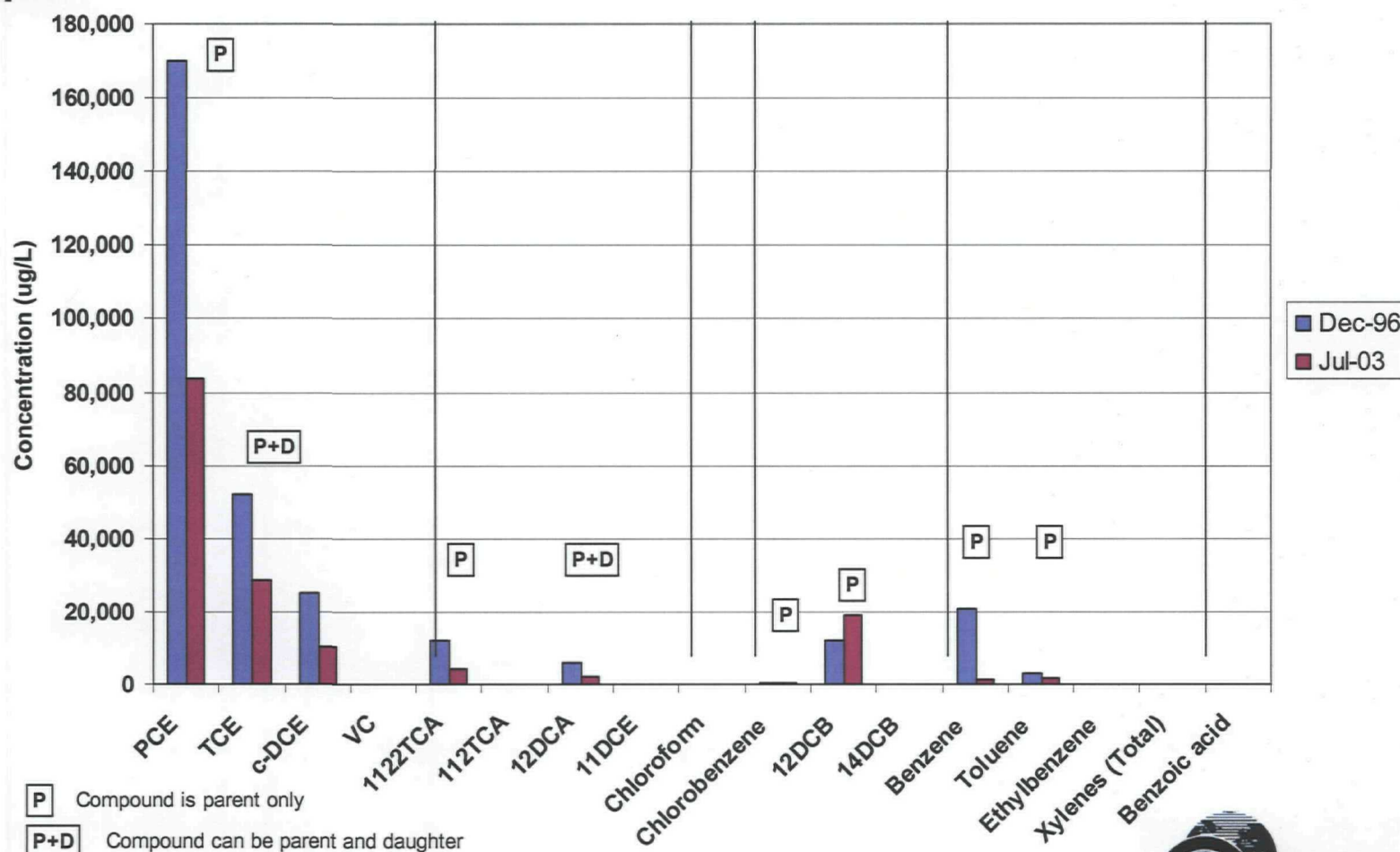
Overburden Source Well S-12



Overburden Downgradient Well S-17



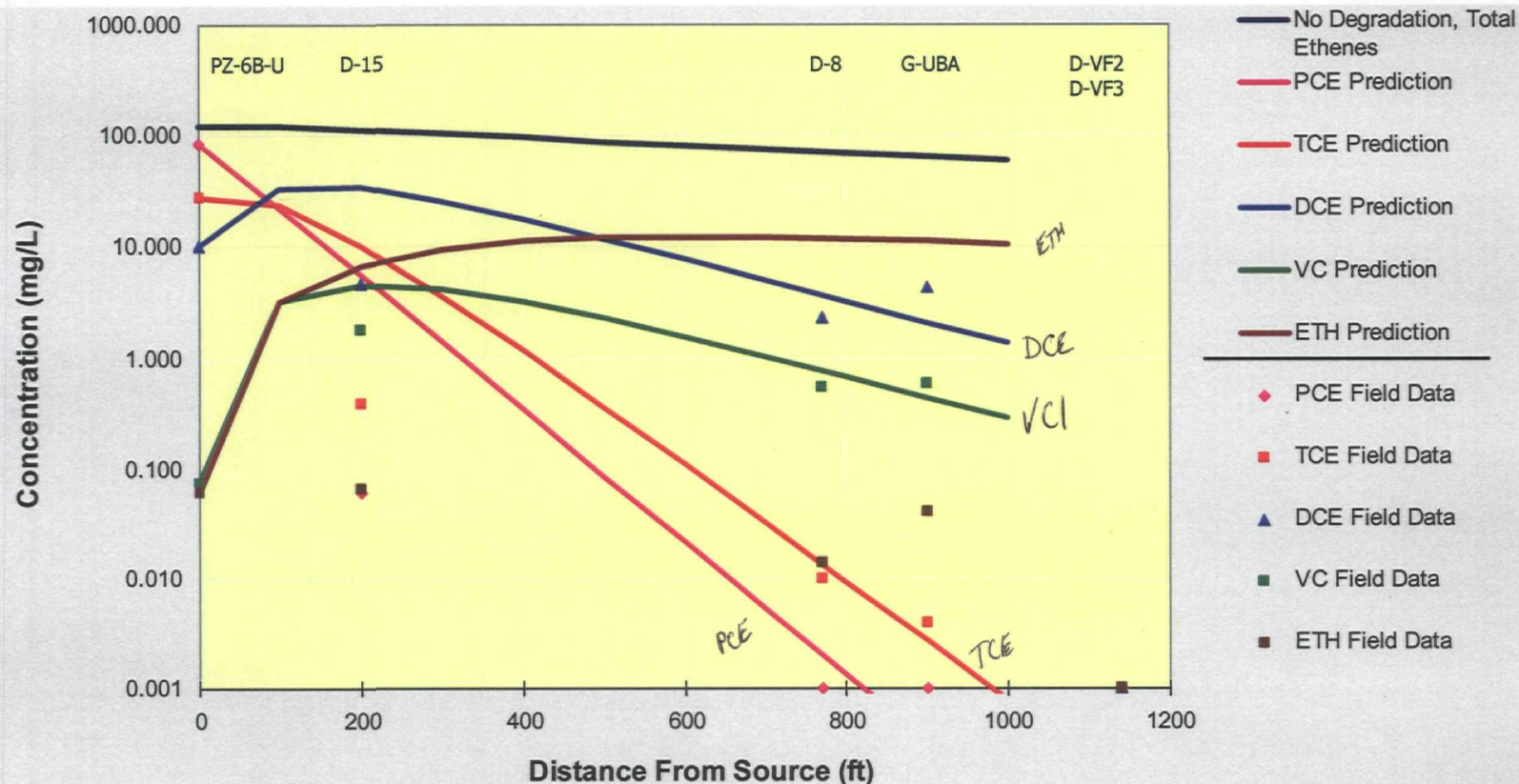
Shallow Bedrock Source Well PZ-6B-U



Chlorinated Ethene Daughter-to-Parent Ratio Along Flow Line (MKS)

Well ID	Distance Along Flow Path [feet]	<u>cis + VC + ethene</u> PCE + TCE [mol/mol]
PZ-6B-U	0	0.2
D-15	200	23.8
D-8	770	285.1
G-UBA	900	816.4

Biodegradation of Chlorinated Ethenes - BIOCHLOR



MKS
ACQUIRED
ONLY

BIOCHLOR Results

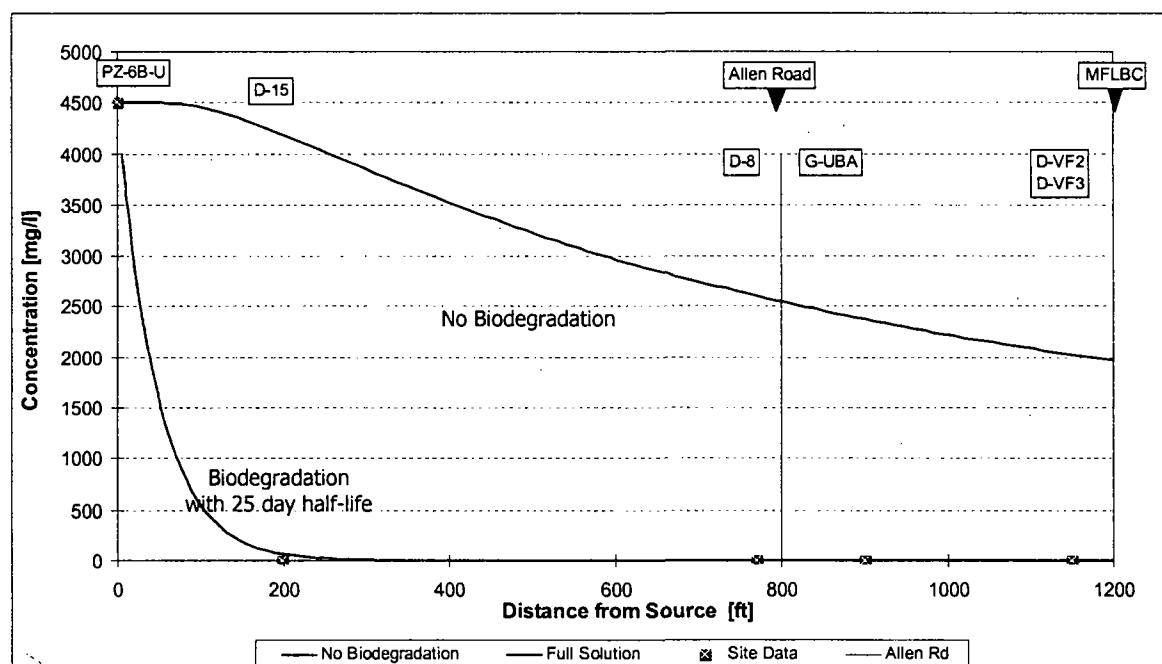
- Half-life times for chlorinated ethenes:

- PCE 79 days
- TCE 83 days
- cisDCE 480 days
- vinyl chloride 120 days

Degradation of Other VOCs

- Steady State Two-Dimensional Advection/Dispersion Model with Reaction Terms (Degradation) Along Plane of Symmetry (Centerline)
- Domenico and Schwartz, 1990, *Physical and Chemical Hydrogeology*

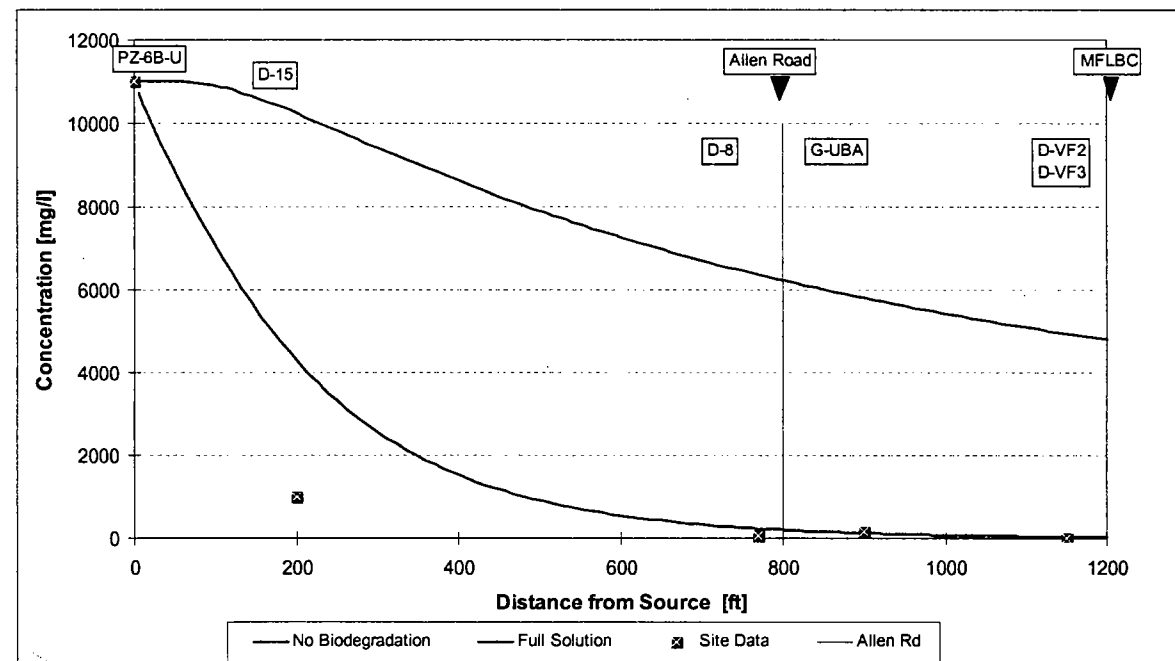
1,1,2,2-TeCA
-estimated
half-life=25 days



Degradation of Other VOCs

- Steady State Two-Dimensional Advection/Dispersion Model with Reaction Terms (Degradation) Along Plane of Symmetry (Centerline)
- Domenico and Schwartz, 1990, *Physical and Chemical Hydrogeology*

Benzene
-estimated
half-life=200 days



Half-Lives of Site VOCs

■ PCE	79 days
■ TCE	83 days
■ cis-DCE	480 days
■ Vinyl Chloride	120 days
■ TeCA	25 days
■ 1,2-dichloroethane	130 days
■ benzene	200 days
■ 1,2-dichlorobenzene	400 days
■ chlorobenzene	800 days

Consistent with published values

Natural Attenuation Indicators

■ Background:

- DO: 0.4 mg/L
- ORP: 21-53 mV
- Nitrate: <0.8 mg/L
- Fe+2: <0.05 mg/L
- Chloride: <1 mg/L


*Oxidation
Reduction
Potential*

■ Plume Core

- DO: 0.0 mg/L
- ORP: -270 mV
- Nitrate: <0.1 mg/L
- Fe+2: 2.3 mg/L
- Chloride: 155 mg/L

*(-450 is about
the highest
you can get)*

Operable Unit Division

- OU-0: Site-wide (already existing)
- OU-1: LTRA (already existing)
- OU-2: Groundwater and Soil 
- OU-3: Feeder Creek and MFLBC sediments

Risk Driving Chemicals

■ Surface Soils

- Mirex
- Manganese (background?)
- Arsenic (background?)
- Iron (background?)

Comments

~~☐ ☐ chloro.~~



Risk Driving Chemicals

- Subsurface Soils
 - 1,1,2,2-Tetrachloroethane
 - PCE
 - 1,2-DCA
 - Benzene
 - Chlorobenzene
 - Vinyl Chloride
 - Mirex



Risk Driving Chemicals

- Groundwater
 - 1,1,2,2-Tetrachloroethane
 - TCE
 - PCE
 - 1,2-DCA
 - Benzene
 - Vinyl chloride

Remedial Action Objectives for OU-2

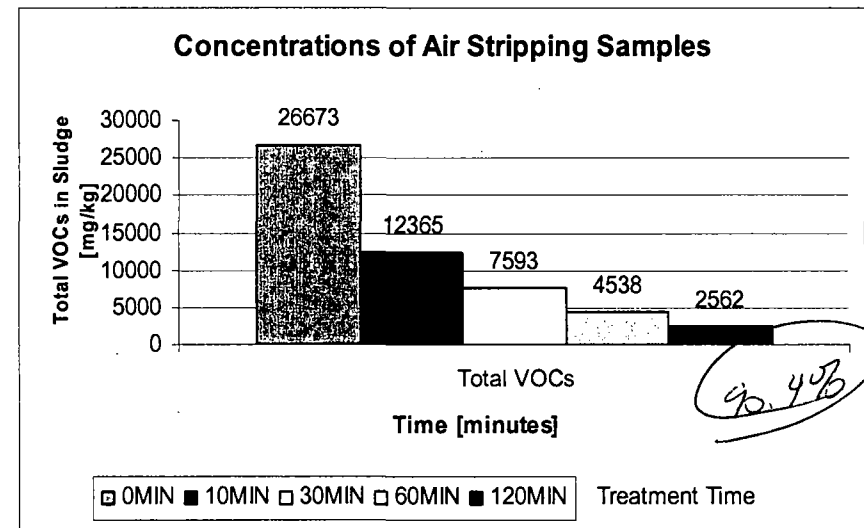
- RAO-1: Mitigate Future Release from former Ponds 1 and 2
- RAO-2: Mitigate Future Exposures to former Ponds 3, 4, and 7 Fill *the fill material (sludge) in*
- RAO-3: Mitigate Shallow Groundwater Discharges *to feeder creek*
- RAO-4: MKS Groundwater Receptor Protection/ Restoration to MCLs *(Joe/John →)*
- RAO-5: Eliminate On-Property Residential and Groundwater Use Pathways *(TO INCLUDE*
- RAO-6: Mitigate Future Worker and Ecological Exposures to Soil and Sediments) *← Δ since last mts*

Retained Technologies for RAO-1 (Former Ponds 1 and 2)

- *In-Situ Treatment:*
 - *Organics Removal/Stabilization/Solidification*
 - Thermal desorption
- Containment:
 - Capping
 - Vertical barriers
 - Horizontal barriers

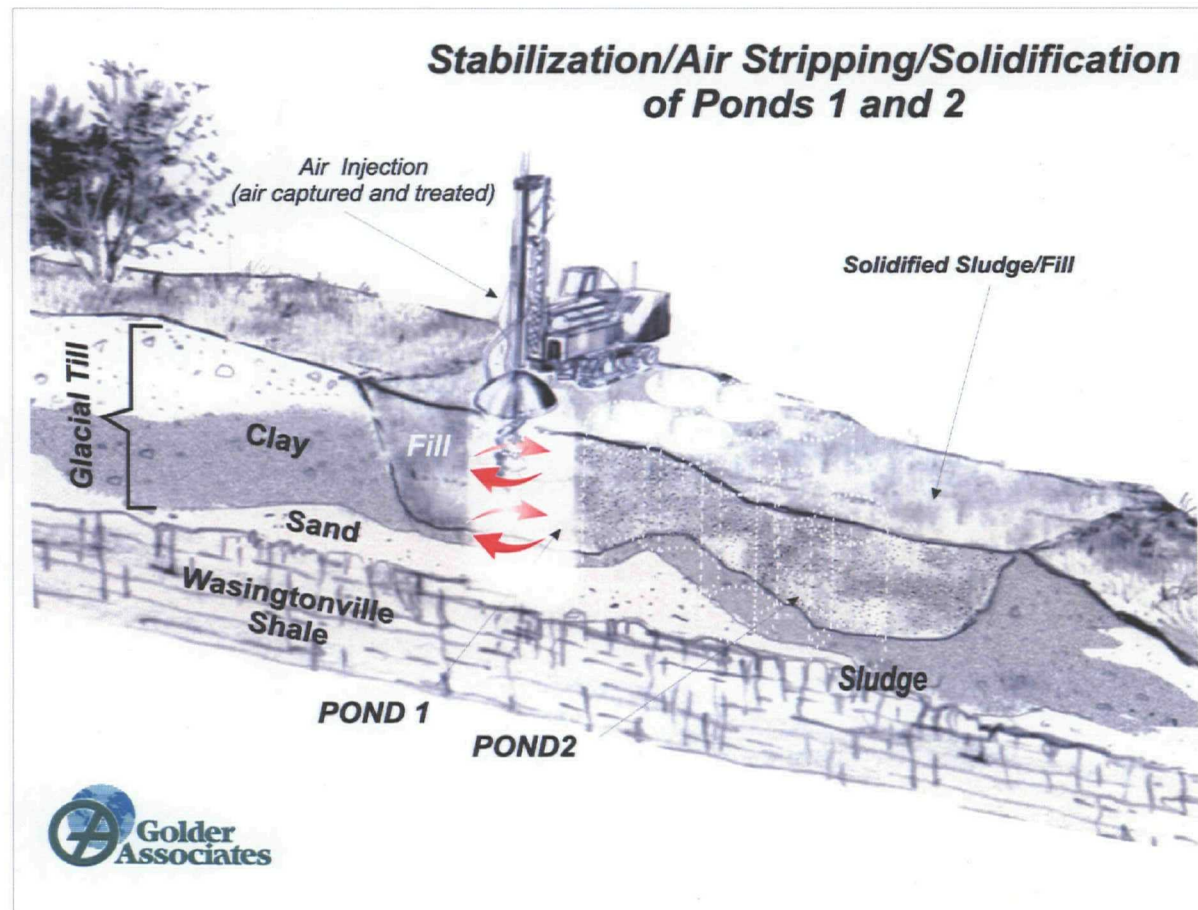
In-Situ Air Stripping / Solidification Technology

- Treatability Study (Carlstadt, NJ Superfund site)
 - VOC reduction approx. 95%
 - Reduced leachability of VOC by approx. 95%
 - Reduced leachability of heavier chlorinated compounds > 95%

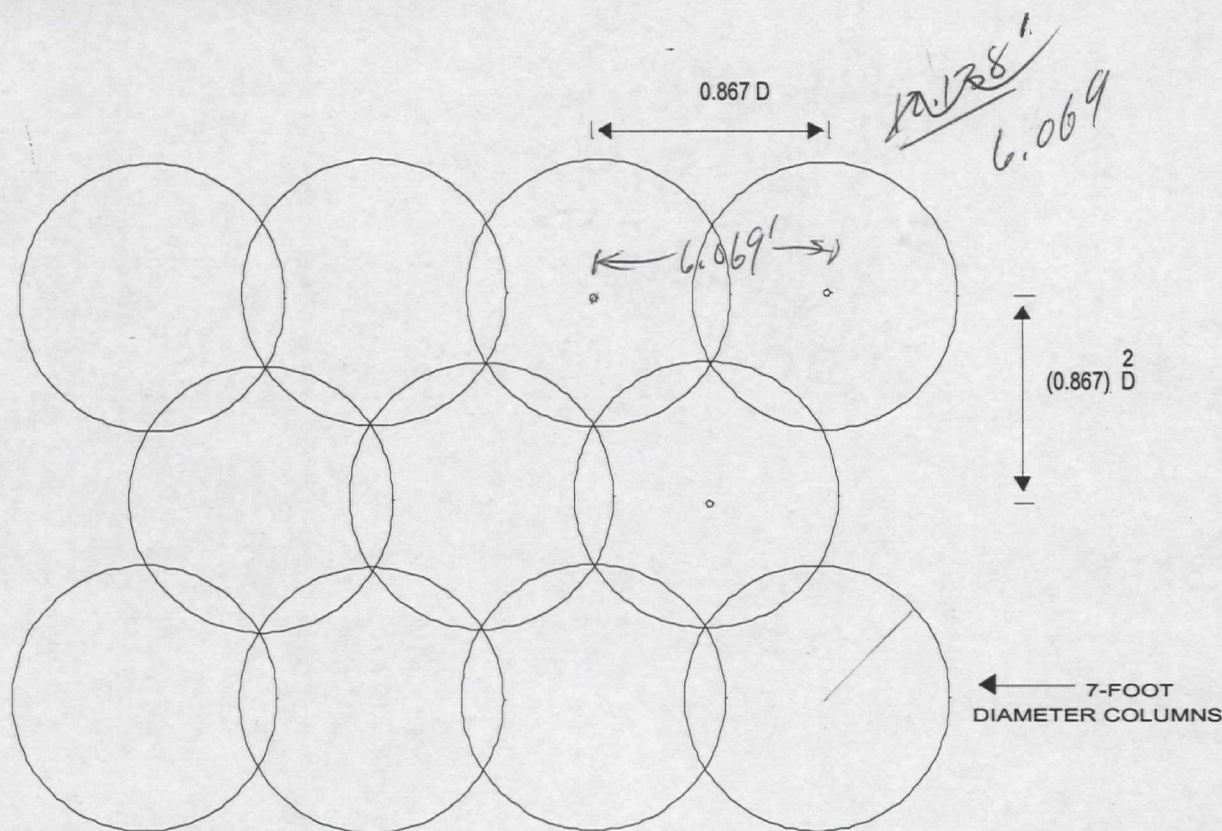


- USEPA selected technology in ROD

In-Situ Air Stripping / Solidification Technology



In-Situ Air Stripping / Solidification Technology



TYPICAL IN-SITU SOIL MIXING COLUMN LAYOUT SCHEMATIC
(NTS)

In-Situ Air Stripping / Solidification Technology



In-Situ Air Stripping / Solidification Technology



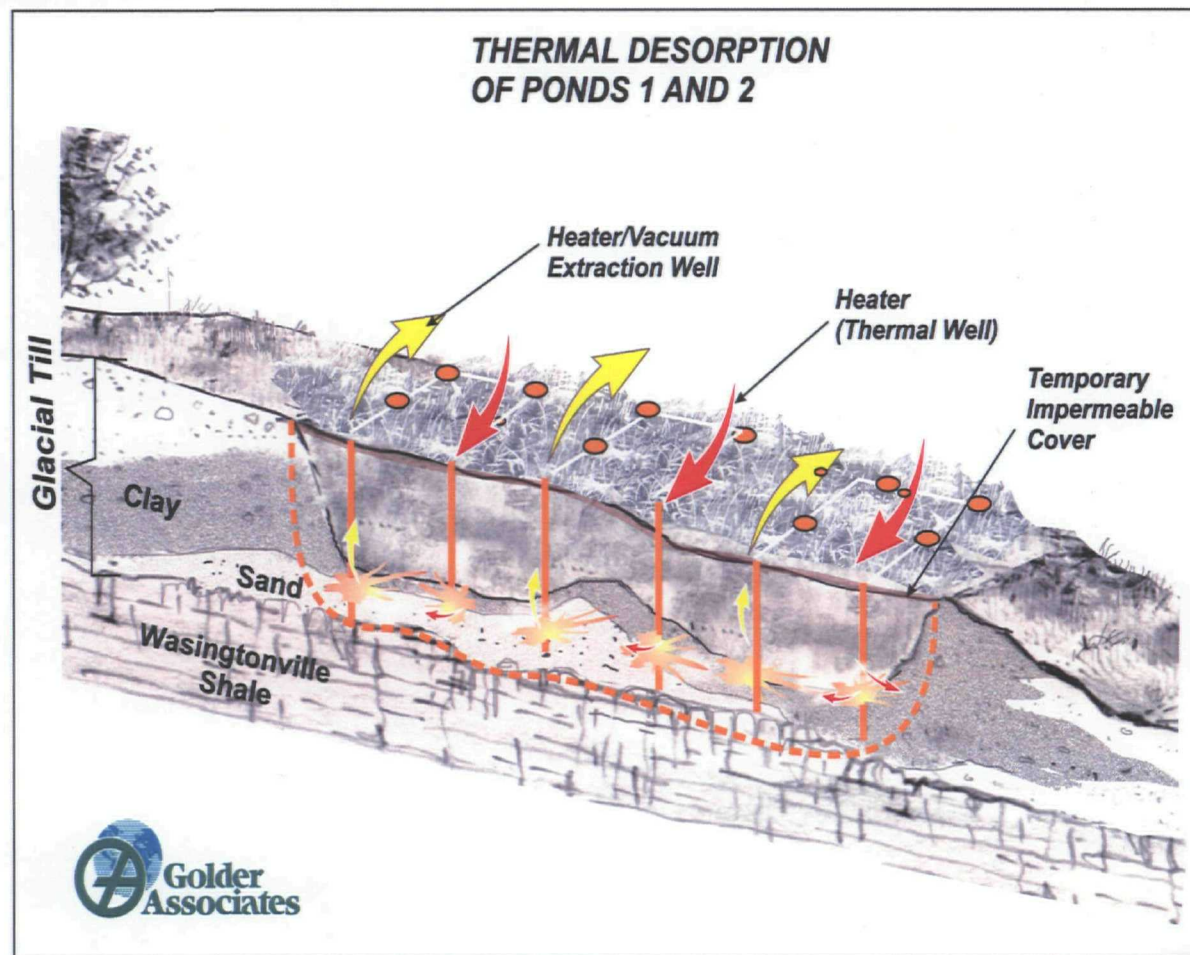
In-Situ Air Stripping / Solidification Technology



Retained Technologies for RAO-1 (Former Ponds 1 and 2)

- *In-Situ Treatment:*
 - Organics Removal/Stabilization/Solidification
 - *Thermal desorption*
- Containment:
 - Capping
 - Vertical barriers
 - Horizontal barriers

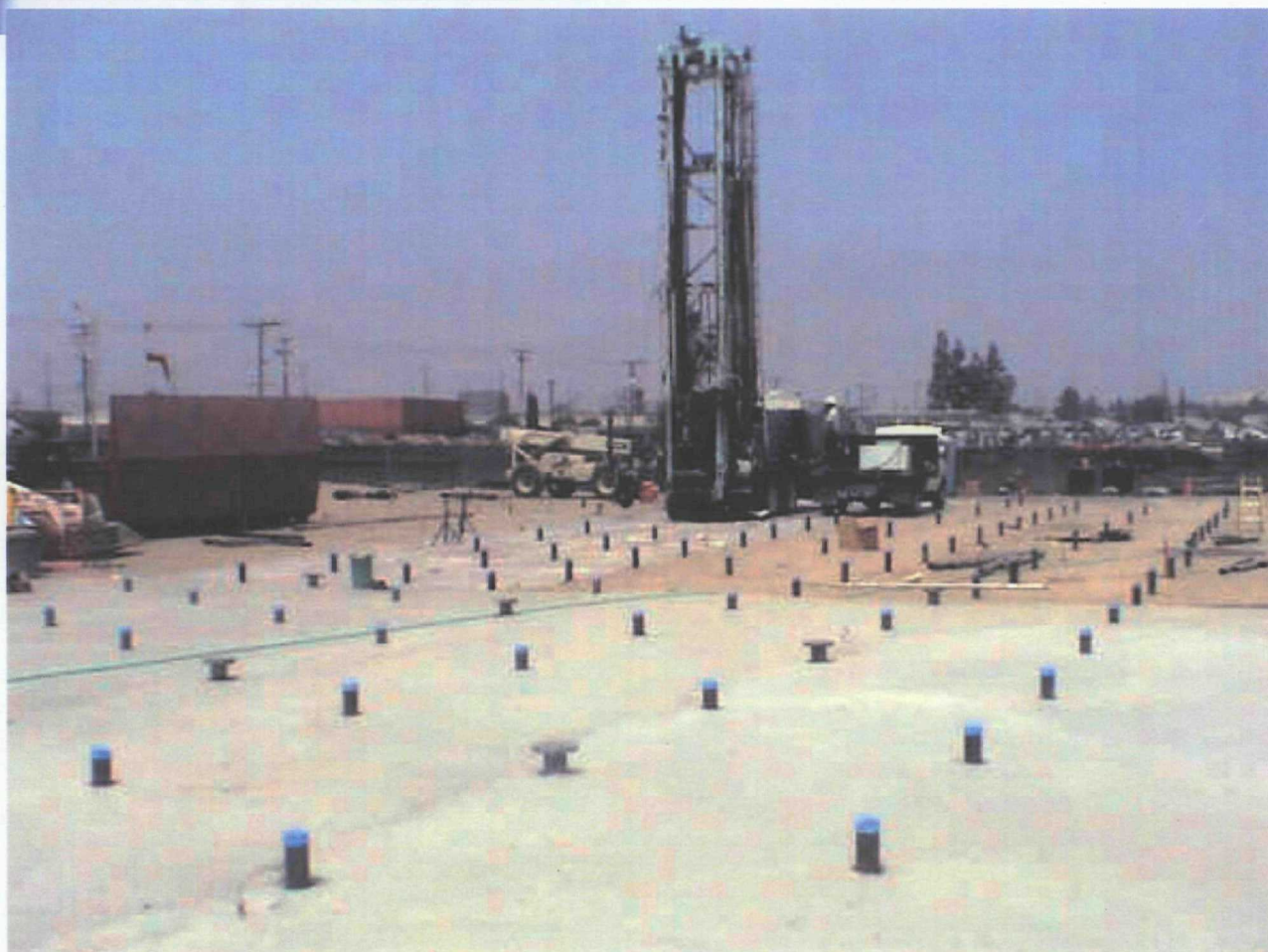
In-Situ Thermal Desorption Technology



In-Situ Thermal Desorption Technology



In-Situ Thermal Desorption Technology

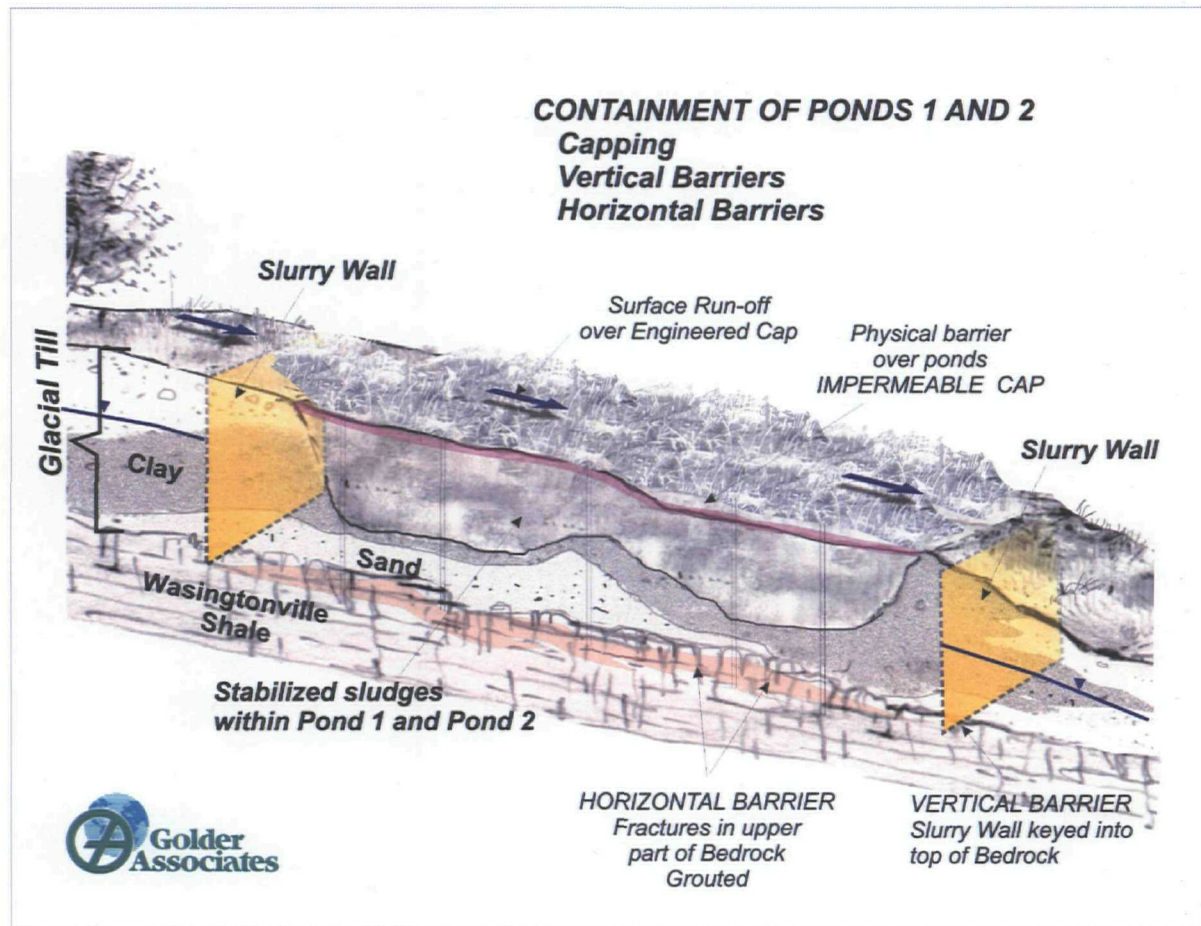


Retained Technologies for RAO-1 (Former Ponds 1 and 2)

- In-Situ Treatment:
 - Organics Removal/Stabilization/Solidification
 - Thermal desorption

- *Containment:*
 - *Capping*
 - *Vertical barriers*
 - *Horizontal barriers*

Containment – Pond 1 and 2



Retained Technologies For RAO-2 (Former Ponds 3, 4, and 7)

- Containment:
 - Standard permeable cap (Former Ponds 3 and 7)
 - Sideslope armoring (Former Pond 4)
 - Cap enhancement (Former Pond 4)
- Soil Modifications:
 - In-situ stabilization to provide bearing strength for cap (Former Ponds 3 and 7)
- In-Situ Treatment:
 - Stabilization / solidification (Former Pond 7)

Retained Technologies For RAO-3 (Shallow Groundwater)

- On-Facility Collection and Treatment:
 - Continued operation of LCS-1 and LCS-2
- Off-Facility Collection:
 - Collection trench
 - New or expanded treatment
- In-Situ Treatment:
 - Collection trench with chemical oxidation
 - Collection trench with reactive iron (NZVI) and accelerated biodegradation

Leachate
Collection
System



Retained Technologies For RAO-3 (Shallow Groundwater)

- On-Facility Collection and Treatment:
 - Continued operation of LCS-1 and LCS-2
- Off-Facility Collection:
 - Collection trench
 - New or expanded treatment
- *In-Situ Treatment:*
 - Collection trench with chemical oxidation
 - *Collection trench with reactive iron (NZVI) and accelerated biodegradation*

Nanoscale Zero-Valent Iron Particles (NZVI)

- Lehigh University
- 50 nm size iron particles
- High reactive surface $> 25,000 \text{ m}^2/\text{kg}$
- Treatment of:
 - Chlorinated solvents
 - Chlorinated pesticides
 - Other organics (M&O BTRP)

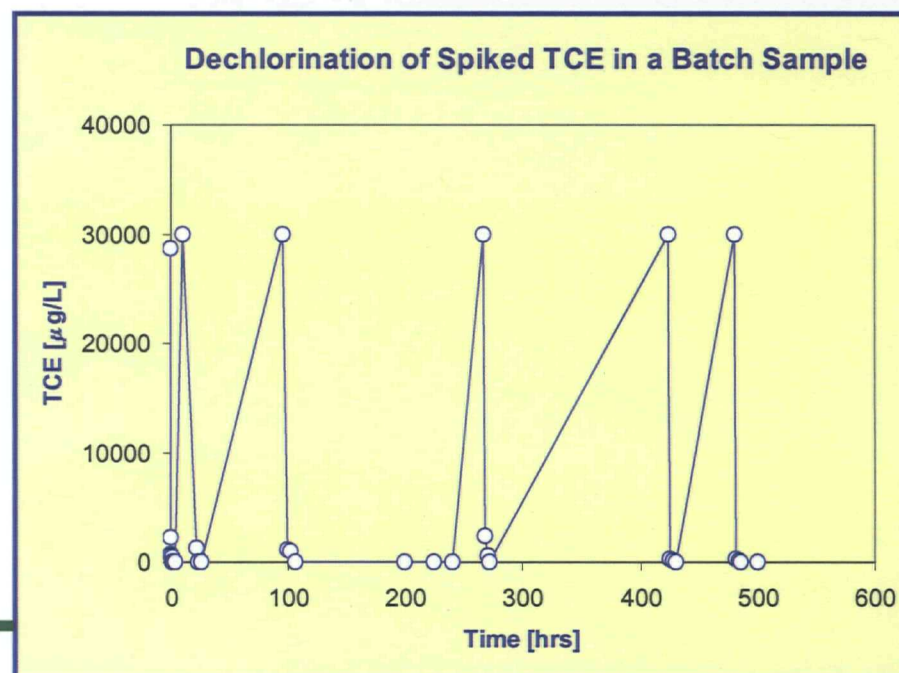
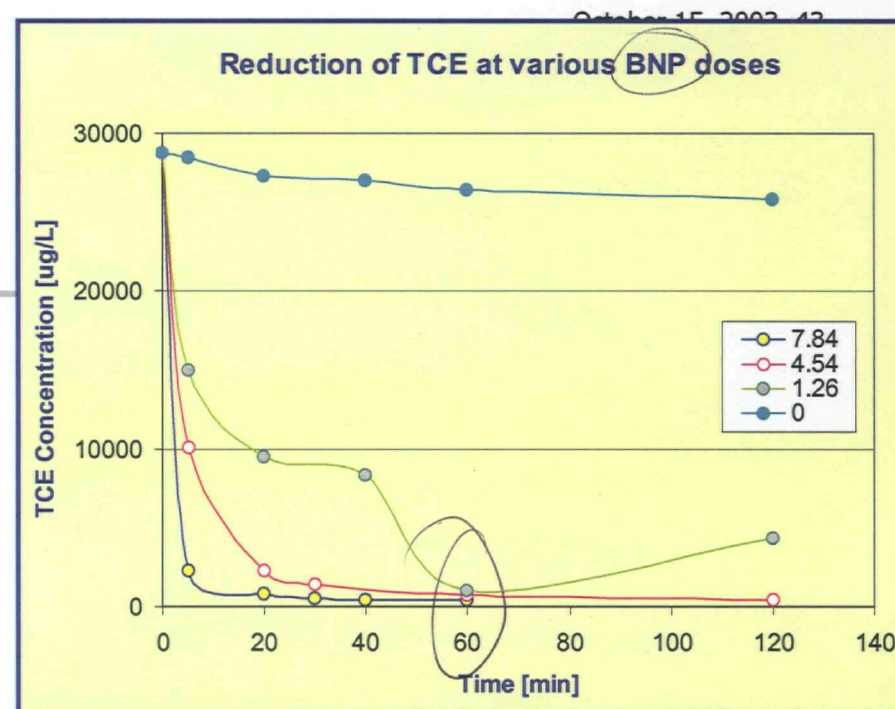
Laboratory Studies - TCE

Laboratory trial

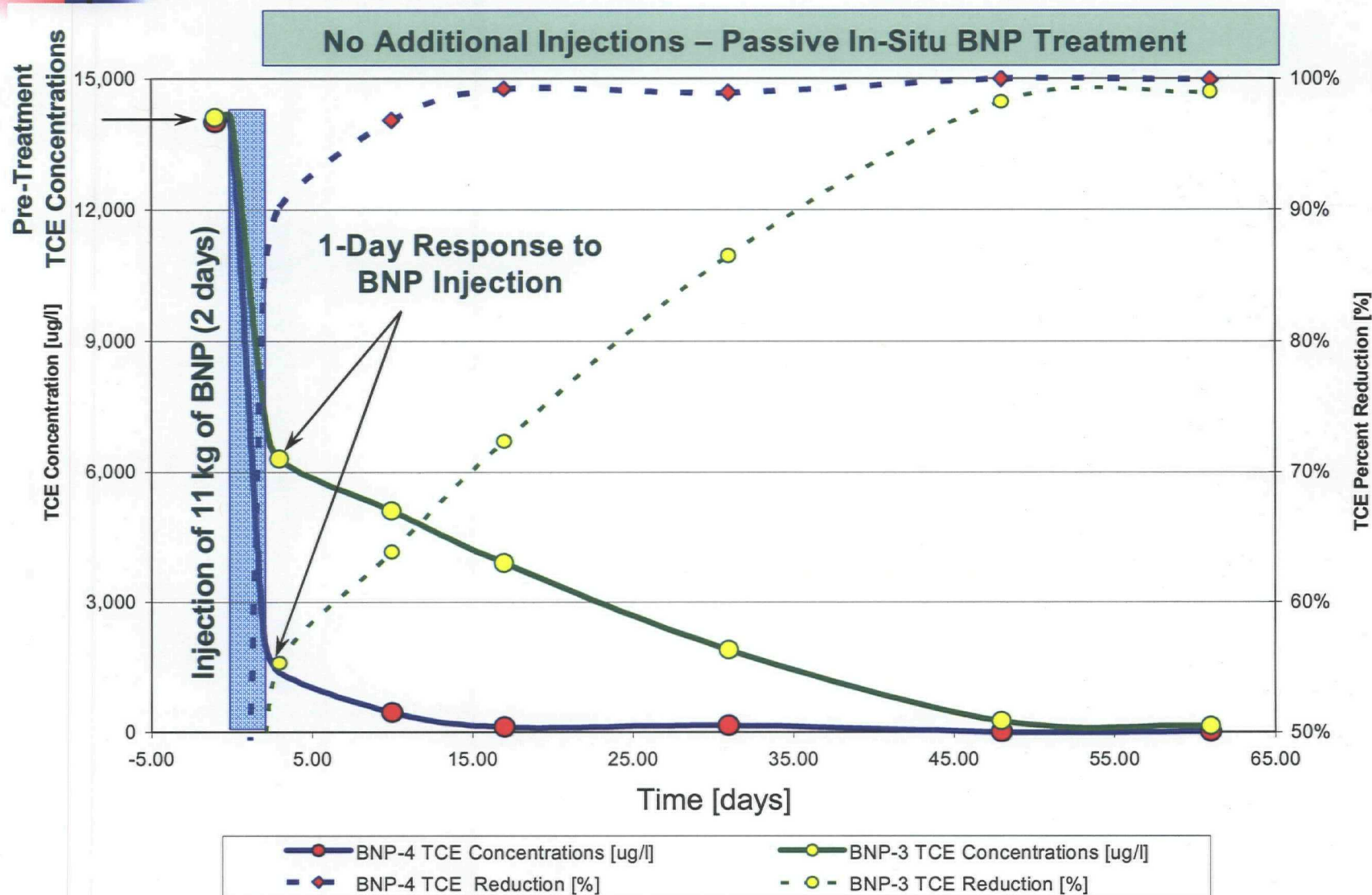
experiments using
groundwater from the
Salem Site:

- Reduction of 30 ppm-TCE concentrations in minutes
- Similar treatment results through a series of 4 lab spikes of 30 ppm-TCE

*Bi-metallic
Nanoscale
Iron
Particle
(BNP)*



Field Studies - TCE Reduction in Wells BNP-4 and BNP-3



Retained Technologies for RAO-4 (MKS Groundwater)

- Source Area Hydraulic Containment
 - Extraction wells
 - New or upgraded treatment plant / discharge
- Source Area In-Situ Treatment
 - Reactive Iron (NZVI) and Accelerated Bioremediation
 - Chemical oxidation
- Plume In-Situ Treatment
 - Reactive Iron (NZVI)/Accelerated Bioremediation
 - Chemical Oxidation
 - Monitored Natural Attenuation



Retained Technologies for RAO-5

(On and Off-Facility Residential
and Groundwater Use Pathways)

- Institutional Controls / Deed Restrictions

Retained Technologies for RAO-6

(On and Off-Facility Soil and Sediments)

- Containment:
 - Physical Barriers (soil caps, pavement, buildings)
 - Sediment channel liners
- Removal of Hot-Spots:
 - Conventional excavation (consolidation on-site or Off-site disposal)
- In-Situ Treatment:
 - Conventional SVE
 - Stabilization/solidification
- Institutional Controls



Remedial Alternative Screening Criteria

- Effectiveness (primary criteria)
 - Ability to meet RAOs
 - Potential short-term impacts to human health
 - Reliability
- Implementability
 - Technical (workable)
 - Administrative (permits, availability of equipment/services)
- Cost
 - Relative to other alternatives for a given RAO

Alternative 1

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
•Continue operation of LCS1 and LCS2 •No further Remedial Actions	<i>Low</i>	<i>Easily Implemented</i>	<i>Low</i>	<i>Yes *</i>

* For baseline comparison as required by NCP

\$300K / yr.

Alternative 2

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> •In-situ treatment of Ponds 1 and 2 (stripping/stabilization/solidification) •Off-facility shallow groundwater collection and ex-situ treatment •Institutional Controls and cover* 	<p><i>Low to High</i></p> <ul style="list-style-type: none"> •High for meeting RAO-1 and RAO-2, RAO-3, RAO-5 and RAO-6 •Low for RAO-4 (MKS groundwater restoration to MCLs), however, there are no groundwater receptors •Provides protection of human health and environment receptors through <ol style="list-style-type: none"> 1.Current absence of complete exposure pathways (groundwater) 2.Groundwater naturally contained 3.Elimination of exposure pathways (ecological, vapors, residential, groundwater, construction worker) 4.Current industrial worker risks within acceptable range 	<p><i>Moderate to Easy</i></p> <ul style="list-style-type: none"> •All components are implementable •In-situ treatment of Pond 1 and 2 is more difficult to implement 	<p><i>Low to Moderate</i></p>	<p><i>No</i></p>

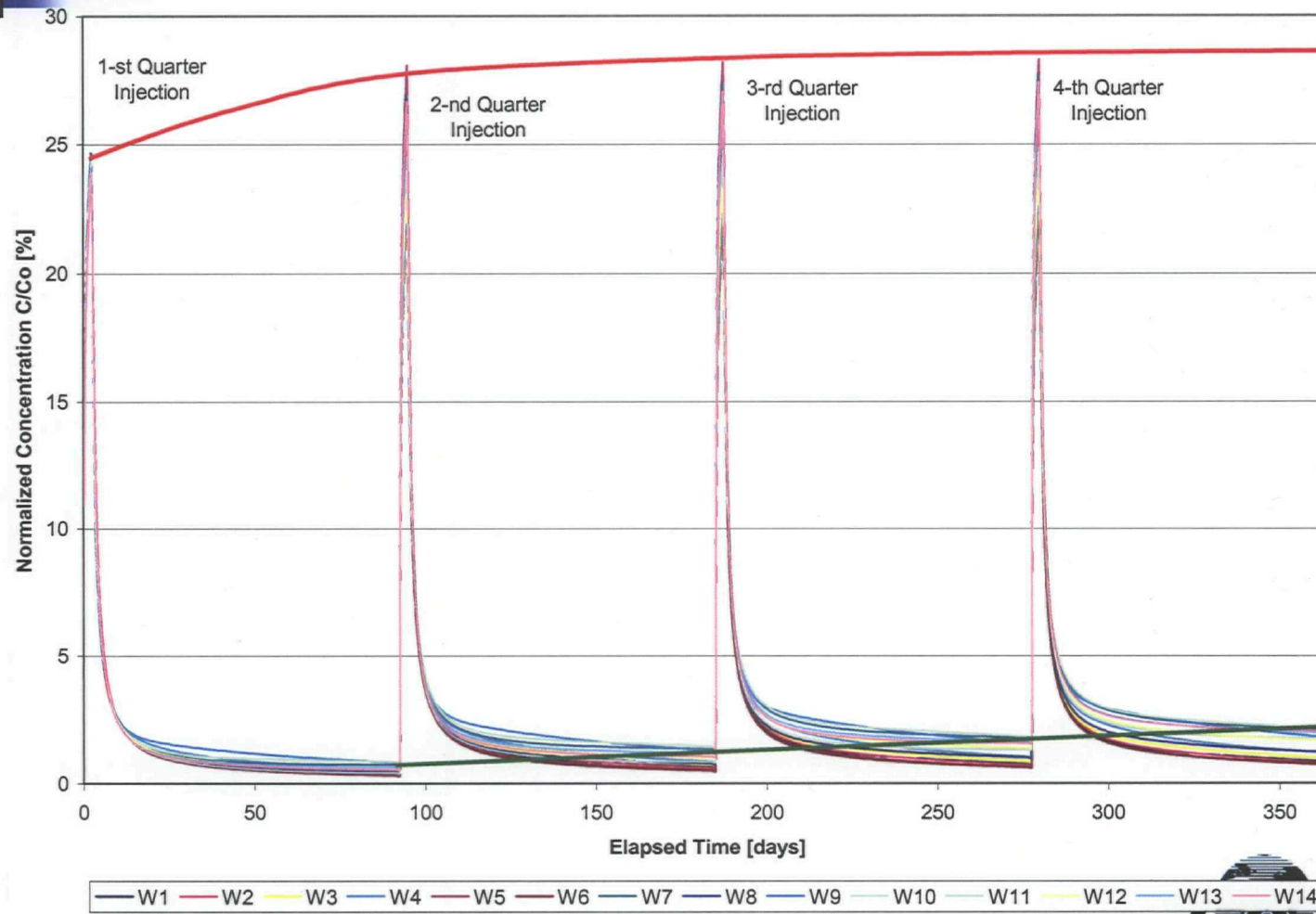
* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.

Alternative 3

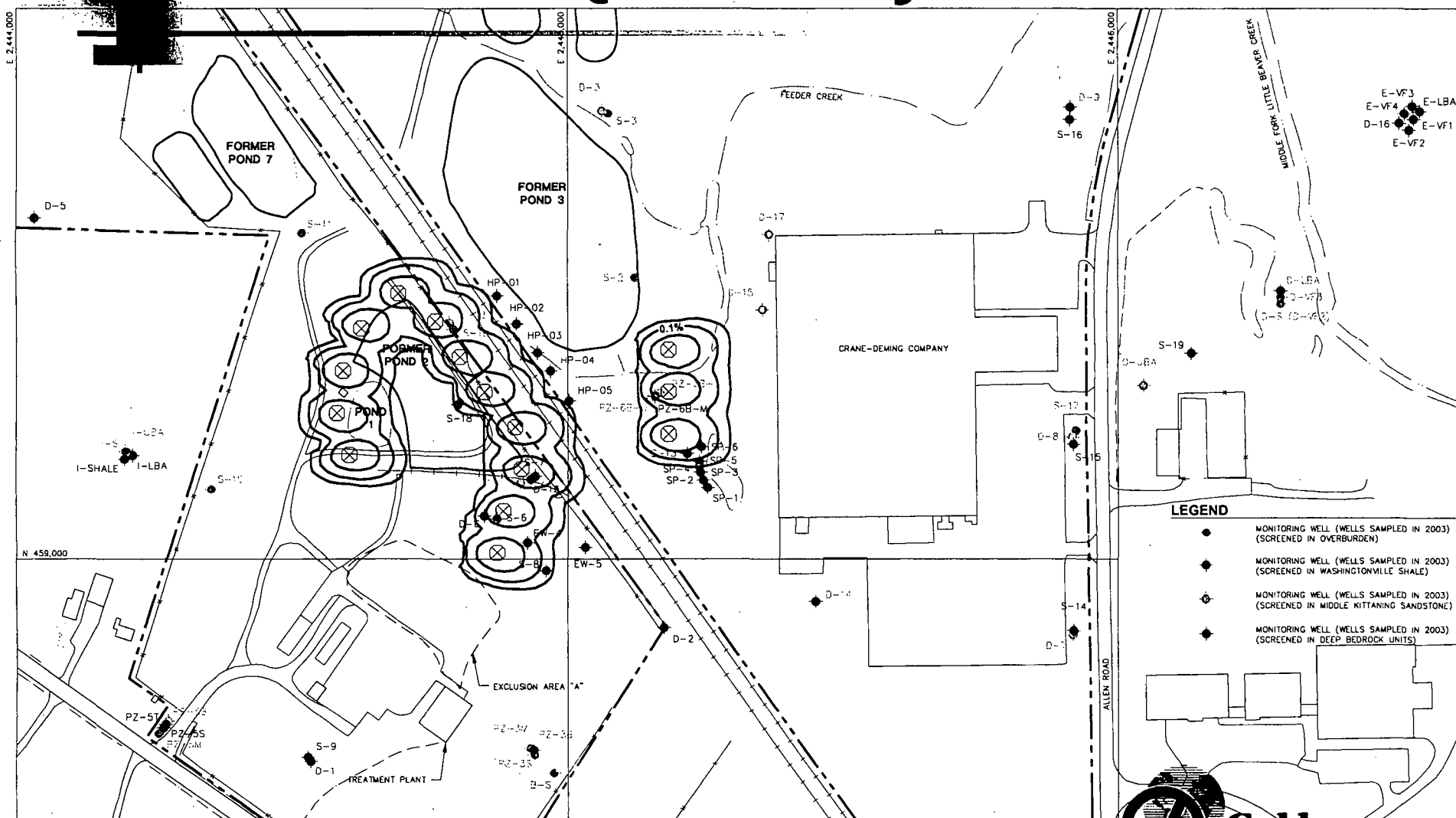
Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> •In-situ treatment of Ponds 1 and 2 (stripping/stabilization/solidification) •Off-facility shallow groundwater collection and ex-situ treatment •In-situ treatment of on-Facility southeast overburden groundwater (NZVI and/or accelerated bioremediation) •In-situ treatment of MKS source area (NZVI and/or accelerated bioremediation) •In-situ treatment of MKS plume (MNA) •Institutional Controls and cover* 	<p><i>High</i></p> <ul style="list-style-type: none"> •Will meet all RAOs •Provides protection of human health and environment 	<p><i>Easy to Moderate</i></p> <ul style="list-style-type: none"> •All components are implementable •In-situ treatment of Pond 1 and 2 and MKS source area are more difficult to implement 	<p><i>Moderate to High</i></p>	<p><i>Yes</i></p>

* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.

Simulated Slurry Concentration

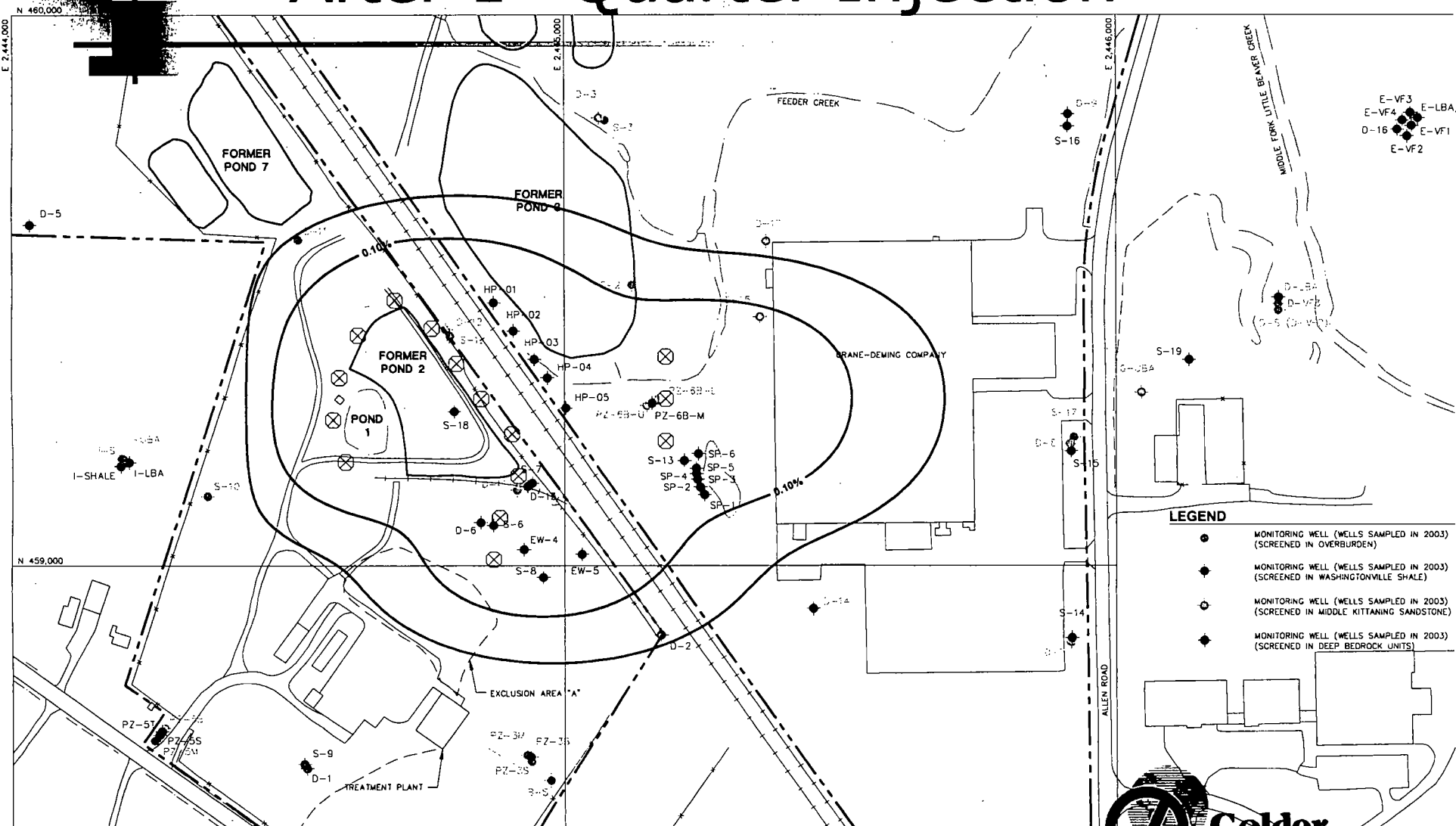


Slurry Concentrations 2 Days After 1st Quarter Injection

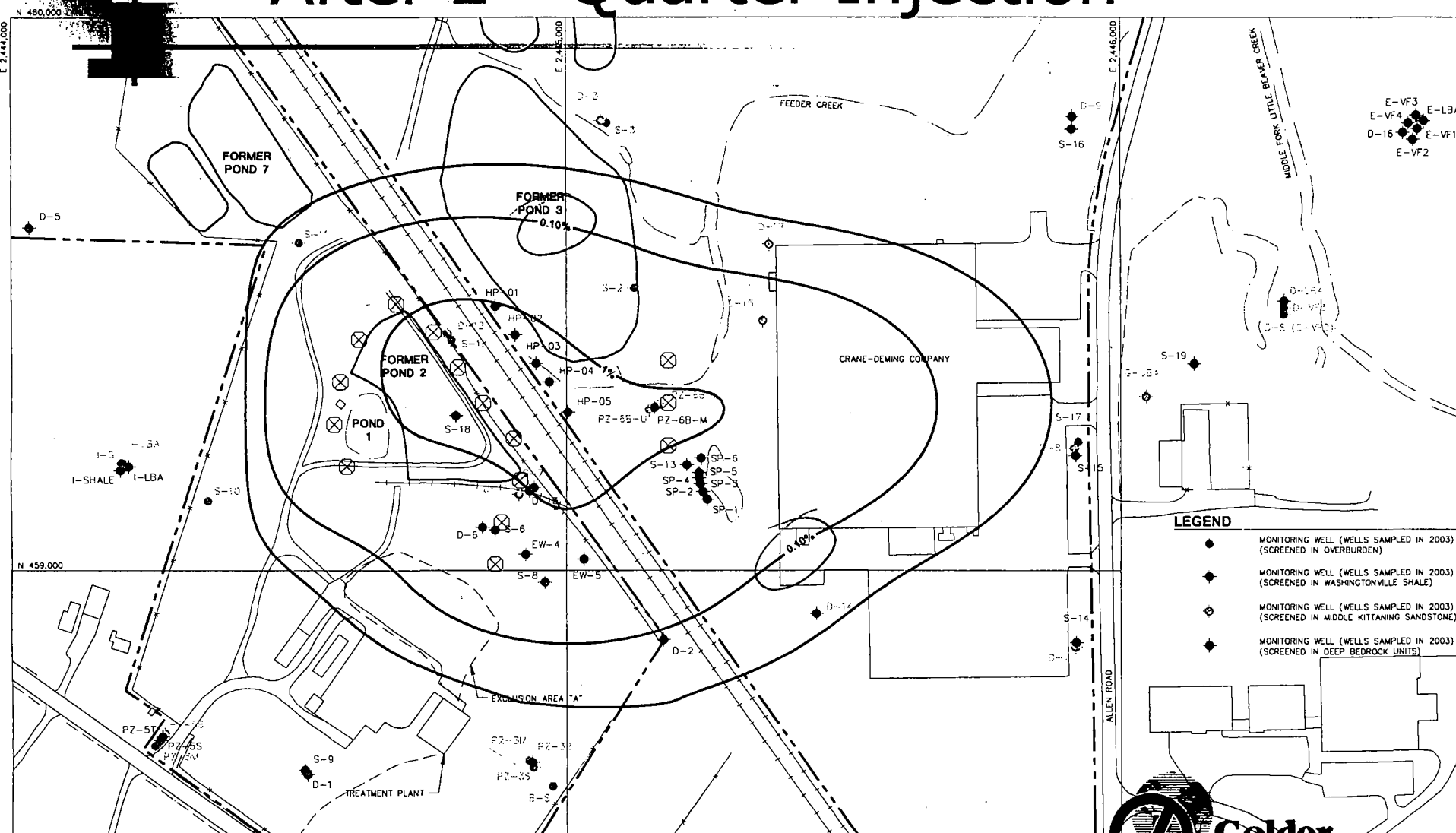




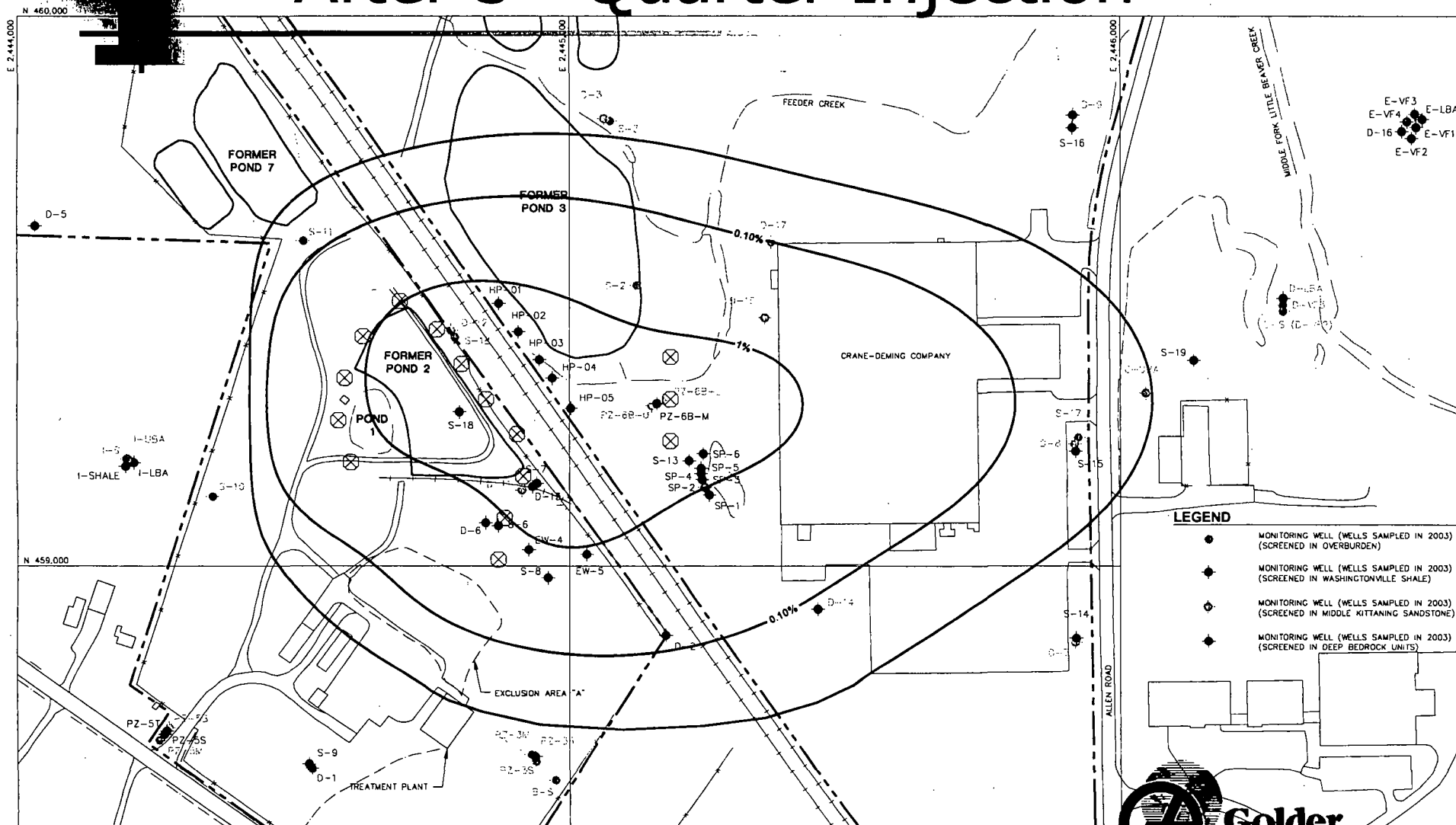
Slurry Concentrations 3 Months After 1st Quarter Injection



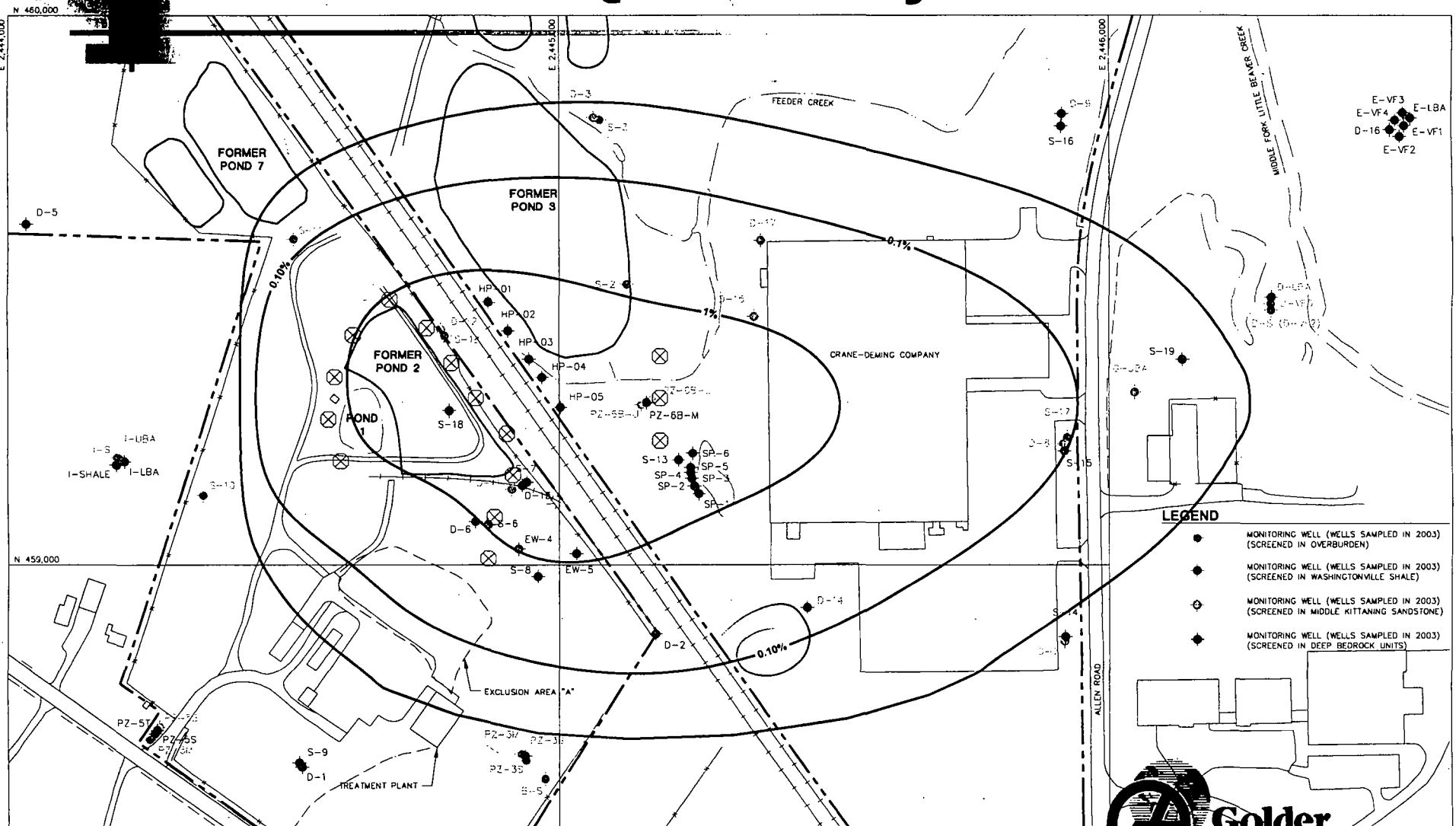
Slurry Concentrations 3 Months After 2nd Quarter Injection



Slurry Concentrations 3 Months After 3rd Quarter Injection



Slurry Concentrations 3 Months After 4th Quarter Injection



Alternative 4

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> •In-situ treatment of Ponds 1 and 2 (thermal desorption) •Off-facility shallow groundwater in-situ treatment (NZVI/ bioremediation) •In-situ treatment of on-Facility Southeast overburden groundwater (NZVI and/or bio) •In-situ treatment of MKS source (NZVI and/or accelerated bioremediation) •In-situ treatment of MKS plume (MNA) •Institutional Controls and cover* 	<p><i>Moderate to High</i></p> <ul style="list-style-type: none"> •Will meet all RAOs •Provides protection of human health and environment 	<p><i>Easy to Moderate</i></p> <ul style="list-style-type: none"> •All components are implementable •Potential implementability concerns for thermal desorption are to be evaluated 	<i>High</i>	<i>Yes</i>

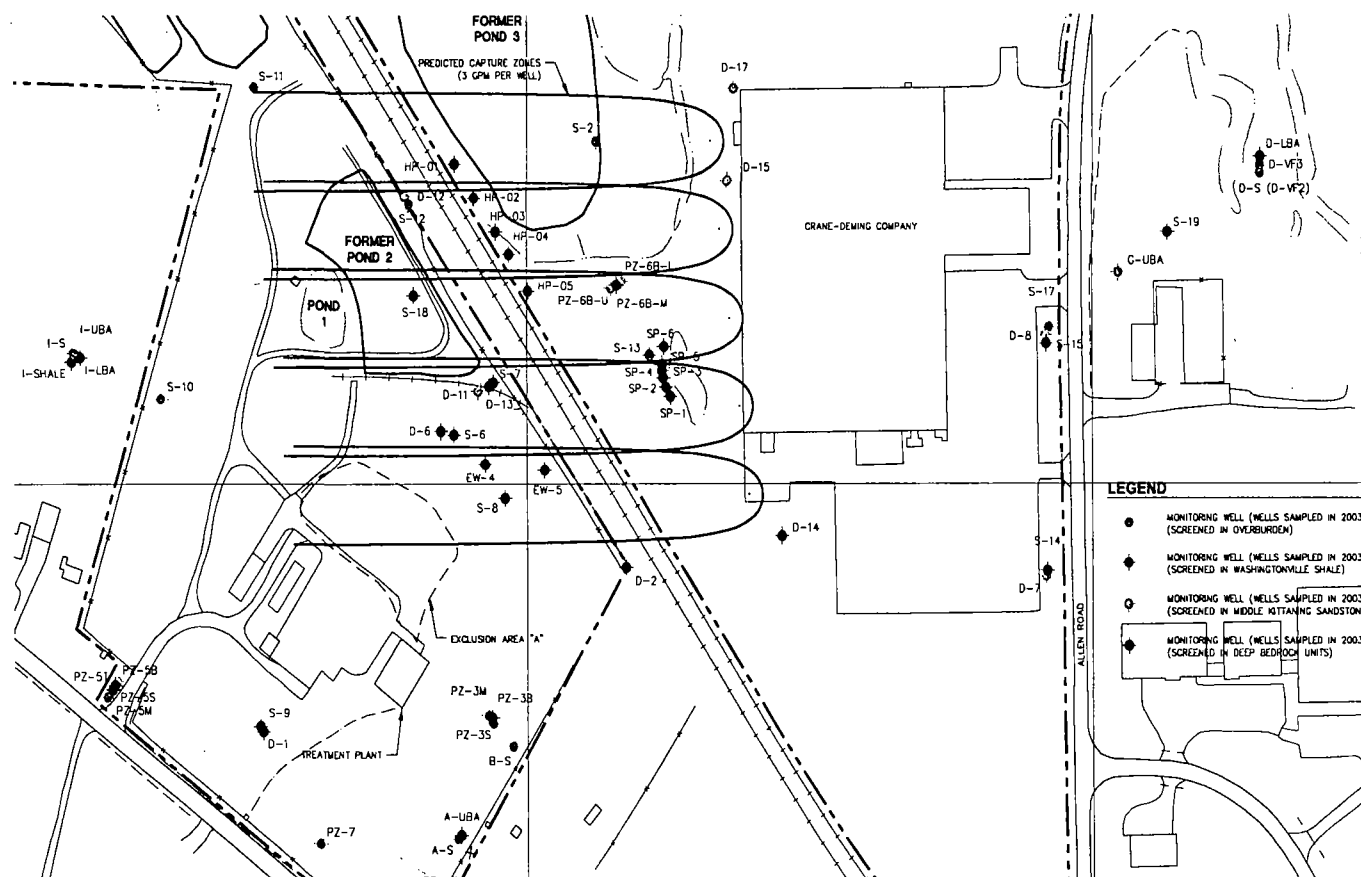
* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.

Alternative 5

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> •Physical containment of Pond 1 and 2 •Off-facility shallow groundwater extraction and treatment •In-situ treatment of on-Facility southeast overburden groundwater (NZVI and/or bio) •MKS source area extraction and treatment •In-situ treatment of MKS plume (MNA) •Institutional Controls and cover* 	<p><i>Moderate to High</i></p> <ul style="list-style-type: none"> •Will meet all RAOs except for possibly RAO-2 – Pond 1 and 2 containment effectiveness will be evaluated in detail •Provides protection of human health and environment 	<p><i>Easy to Moderate</i></p> <ul style="list-style-type: none"> •All components are easy to implement 	<p><i>Moderate to High</i></p>	<p>Yes</p>

* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.

Source Area Hydraulic Containment



Alternative 6

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> •Physical containment of Pond 1 and 2 •In-situ treatment of off-Facility shallow groundwater (chem-ox) •In-situ treatment of on-Facility southeast overburden groundwater (chem-ox) •In-situ treatment of MKS source (chem-ox) •Institutional Controls and cover* <p><i>(permanganate, ferrous vermiculite, peroxide etc)</i></p>	<p><i>High to Low</i></p> <ul style="list-style-type: none"> •Will meet RAO-1, RAO-2, RAO-5 and RAO-6 •Low effectiveness for meeting RAO-3 and RAO-4 •Pond 1 and 2 containment effectiveness requires detailed evaluation •Chemical oxidation of MKS groundwater will eliminate natural attenuation •Questionable protection of human health and environment due to low effectiveness for meeting RAO-3 and RAO-4 	<p><i>Moderate to Difficult</i></p> <ul style="list-style-type: none"> •Chemical oxidation of shallow and MKS groundwater is expected to be difficult to implement <p><i>will "kill" bugs of MNA system</i></p>	<p><i>Moderate to High</i></p>	<p><i>No</i></p>

* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.

Alternative 7

Alternative Components	Screening Criteria			
	Effectiveness	Implementability	Relative Cost	Retain
<ul style="list-style-type: none"> • In-situ treatment of Ponds 1 and 2 (thermal desorption) • Shallow off-Facility groundwater extraction and ex-situ treatment • In-situ treatment of on-Facility Southeast overburden groundwater (NZVI and/or bio) • MKS source extraction and ex-situ treatment • In-situ treatment of MKS plume (NZVI or accelerated bioremediation) • Institutional Controls and cover* 	<ul style="list-style-type: none"> • Will meet all RAOs • Provides protection of human health and environment 	<p><i>Easy to Moderate</i></p> <ul style="list-style-type: none"> • This alternative is no more easily implemented than other effective alternatives • Potential implementability concerns with thermal desorption require further evaluation 	<u>Very High</u>	<u>No</u>

* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.



Site Wide Alternatives

ALTERNATIVES	RAO-1 Ponds 1 and 2	RAO-2 Ponds 3, 4, and 7	RAO-3: Shallow Groundwater		RAO-4 MKS Groundwater		RAO-5: Groundwater Residential Use	RAO-6 Soil and Sediment
			Eastern (Off- Facility)	Southern (On-Facility)	Source	Plume		
Alt-1	No Further Action	-	LCS1 & LSC2	-	-	-	-	ICs and Cover*
Alt-2	Physical Treatment (S/S/S)	ICs and Cover*	Ex-situ Treat	-		-	ICs	ICs and Cover*
Alt-3	Physical Treatment (S/S/S)	ICs and Cover*	Ex-situ Treat	In-situ Treat (NZVI and/or bio)	In-situ Treat (NZVI and/or bio)	In-Situ Treat/MNA	ICs	ICs and Cover*
Alt-4	Thermal Desorption	ICs and Cover*	In-situ Treat (NZVI and/or bio)	In-situ Treat (NZVI and/or bio)	In-situ Treat (NZVI and/or bio)	In-Situ Treat/MNA	ICs	ICs and Cover*
Alt-5	Containment	ICs and Cover*	Ex-situ Treat	In-situ Treat (NZVI and/or bio)	Ex-situ Treat	MNA	ICs	ICs and Cover*
Alt-6	Containment	ICs and Cover*	In-situ Treat (Chem-ox)	In-situ Treat (Chem-ox)	In-situ Treat (Chem-ox)	-	ICs	ICs and Cover*
Alt-7	Thermal Desorption	ICs and Cover*	Ex-situ Treat	In-situ Treat (NZVI and/or bio)	Ex-situ	In-situ Treat (NZVI and/or bio)	ICs	ICs and Cover*

* Extent of cover dependent on surface soil/sediment mirex levels and associated ecological criteria.



Outstanding Issues

- Mirex in surface soil
- Agency comments on retained alternatives
- Draft Feasibility Study schedule